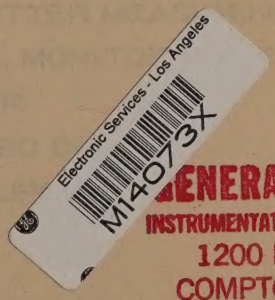
MK-615

WIDE BAND FLUTTER METER

SER. NO.

V AC OPERATION



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SECTION 1

DESCRIPTION

1.1 Introduction

The MK-615 is a wideband (20Hz-100kHz) FM demodulator capable of measuring the wow, flutter, and drift in audio and video tape recorders, phono-players, sound equipment and other recording and reproducing apparatus. Moreover, when used in conjunction with a rotary encoder, it is possible to measure the RPM and drift in rotating mechanisms.

For accuracy, a four-digit counter display is incorporated for direct readout of the input signal frequency and the RPM.

Output connections have been provided recording the drift and flutter characteristics. Flutter waveform observation is also possible with an external oscilloscope.

A particular advantage is the adjustable lowpass filter for use in flutter measurements. Instead fo the 200Hz cutoff in conventional flutter meters, it is possible to set the cutoff frequency as desired, for example, at 0.1 times the measuring frequency. The cutoff limit can be set at 300Hz, or higher, when the input frequency is 3kHz. This permits flutter measurements not hitherto possible due to the frequency cutoff limitation.

Uses

1. With direct signal input:

   a. Flutter characteristics of record/playback equipment such as tape recorders, data recorders, phono-players, etc.

   b. Jitter in the horizontal and vertical sync signals of the VTR and EVR.

   c. Flutter in motors, etc., which include a self-contained rotary encoder or other transducer.

   d. Demodulation of FM signals in the 20Hz-100kHz range.

2. With use of specially selected rotary encoders for MK-615, in measurements of -

   a. Uneven rotation and starting characteristics in large and small motors.

   b. Flutter in phono-players without use of a standard disc.

   c. Rotational characteristics of rollers used in facsimile, copying and printing machines.

   d. Rotational characteristics of machinery for milling, lathes, drill presses, engines for cars, motorcycles, etc.

1.2 Specifications

Flutter Meter Characteristics

Input Frequency Range	20Hz - 100kHz in four ranges: 20-100Hz, 100-1000Hz, 1-10kHz, and 10-100kHz.
Input Voltage Range	30mV - 30Vrms.
Input Impedance	100kΩ ±20%; unbalanced.
Measuring Ranges	
Drift	±0.002% to ±10% in six ranges: 0.03%, 0.1%, 0.3%, 1%, 3%, and 10% at end scales.
Flutter	0.001% to 10% in six ranges: 0.03%, 0.1%, 0.3%, 1%, 3%, and 10% at full scale.
Indication	
Drift	At peak value.
Flutter: Peak value	In accordance with IEC (CCIR, DIN, ANSI, and IEEE standards.
Effective value	In accordance with JIS (Japanese Industrial Standards.
Accuracy	Drift and flutter within ±5% of full scale.
Frequency Response	
Drift	DC - 0.5Hz.
Flutter: Weighted	In accordance with IEC, JIS, and NAB standards.
Unweighted	-3dB ±1dB: 0.2Hz up to 0.1 X input frequency. Rolloff: Better than -15dB/oct above 0.1 X input frequency, and better than -6dB/oct below 0.2Hz.

Output Connections

Frequency Conversion, F/V

Output Voltage	0 to +10V ±20% at open circuit at each frequency range.
Output Impedance	10kΩ ±20%; unbalanced.

Drift

Output Voltage	±1V ±20% at full scale for each range at open circuit.
Output Impedance	10kΩ ±20%; unbalanced.

TO SCOPE (Flutter)

Output Voltage	3Vrms ±20% at open circuit at each full scale range.
Output Impedance	10kΩ ±20%; unbalanced.

TO RECORDER

Output Voltage	Approx. 0.15V DC at full scale.
Output Impedance	10kΩ ±20%; floating.

External Filter Data

Input Impedance	100kΩ ±20%; unbalanced.
Output Impedance	600Ω ±20%; unbalanced.

Frequency Counter Characteristics

Frequency Range	10Hz - 99.99kHz.
Input Voltage	30mV - 30Vrms.
Gate Time	0.1 and 1 second.
Accuracy	±(1count + reference frequency accuracy).
Display	Digital with four figures.
Readout Unit	kHz.
Reference Frequency	a. Local AC line frequency, 50 or 60Hz. b. 600kHz (internal crystal oscillator).
Reference Frequency Accuracy	a. AC line frequency accuracy. b. Crystal oscillator: within ! 30ppm.

Revolutions (RPM) Counter Characteristics

1. With use of a transducer generating one pulse per revolution:

Measuring Range	70 - 9,999RPM in one range.
Accuracy	Within 1RPM, or ±1.7%.
Counter Display	Digital with four figures.
Readout Unit	RPM.
MeasuringTime	1 second.

2. With use of a transducer generating over 100 pulses, in multiples of 100 up to 9,900, per revolution:

Measuring Range	1 to 9,999 RPM in four ranges: 1-10RPM, 10-100RPM, 100-1,000RPM, and 1,000-9,999 RPM.
Accuracy	0.01 RPM (±0.17%): 1-10 RPM. 0.1 RPM (±0.17%): 10-100 RPM. 1 RPM (0.17%): 100-1,000 RPM. 10 RPM(0.17%): 1,000-9,999 RPM.
Counter Display	Digital with four figures.
Readout Unit	RPM.
Measuring Time	1 second.

General Data

Operating Temperature Range	0 to 40°C.
Power Requirements	100, 120, 200, or 240V ±10% (voltage selector provided), 50/60Hz; approx. 32VA.
Stability VS. 10% Change in AC Line Voltage	a. Drift indication: Within ±1%. b. Flutter indication: Within ±1%. c. Frequency counter: Within ±1count. d. RPM counter: Within ±1count.
Dimensions, overall	Approx. 430(W) X 215(H) X 345(D) mm.
Weight	Approx. 8kg.

Accessories, furnished -

Input cord	MC-2204	2 ea.
Output cable	MC-2052-B	1 ea.
Fuse, spare		2 ea.
Instruction manual		1 ea.

SECTION 2

CONTROLS AND CONNECTORS

Before using the MK-615, the operator is advised to become familiar with the function of the different controls and connectors as described in this section.

2.1 Front Panel, Fig. 2-1 (Page -8-A-)

1 INPUT 100kΩ terminals: For the input signal under measurement.

2 LEVEL indicator: Lights when the input signal voltage is sufficient for measurements, i.e. in the 30mV - 30Vrms range.

3 MODE switches: For selecting the measuring mode -

a. FREQ. & REVO. (at in): For frequency and RPM measurements.

b. DRIFT & FLUTTER (at out): For drift and flutter measurements.

4 FREQ. & REVO. switch used as follows -

a. FREQ. (at in): For measuring the frequency alone or the frequency during drift and flutter measurements.

b. REVO. (at out): For measuring the RPM alone, or the RPM during drift and flutter measurements.

5 GATE TIME switches: For setting the gate time of the counter at 0.1 or 1 second when measuring the input frequency.

Condition: MODE switch, 3, at FREQ. & REVO., or FREQ. - REVO. switch, 4, at FREQ.

6 REVO. RANGE switches: For selecting the frequency counter range when measuring the RPM.

Condition: MODE switch, 3, at FREQ. & REVO. ONLY and FREQ - REVO. switch, 4, at REVO.

7 OVERFLOW and UNDERFLOW indicators: Used when measuring the RPM; incorrect setting of the REVO. RANGE switch is indicated when either lamp is on. During the RPM measurements both lamps should not be on.

8 FREQUENCY & REVOLUTION counter display: Indicates the input frequency or RPM depending on the setting of the FREQ. - REVO. switch, 4.

9 TRANSDUCER PULSES X100 switch: Thumbwheel type. For setting the divisor figure when measuring the RPM with use of an external rotary encoder; settable in steps of 100 from 100 to 9900.

10 FREQ. RANGE Hz switch: For setting the range of the input frequency when measuring drift and flutter.

11 SET FREQUENCY dial: Used for fine tuning of the input frequency in conjunction with the FREQ. RANGE switch, 10, when measuring the drift and flutter; the tuned frequency is displayed at FREQUENCY & REVOLUTION, 8.

12 DRIFT % meter: Indicates the frequency drift relative to the tuned input frequency; two scales are used, 0 to ±3% and 0 to ±10%. where the actual readings depend on the settings of the DRIFT RANGE % switch, 13, and DRIFT FINE control, 14.

13 DRIFT RANGE % switch: With six positions for selecting the drift range, 0.03%....10%, at full end scales on the DRIFT % meter.

14 DRIFT FINE control: Dual-knob type. Used in conjunction with the SET FREQUENCY control, 11, to set the DRIFT meter reading at the center "0". The outer (large) knob is used at the DRIFT RANGE % , 13, settings of 10%, 3%, and 1% and the inner knob at settings of 0.3%, 0.1% and 0.03%.

15 FUNCTION switch: Selects the condition for flutter measurements -

a. WTD (Weighted): For tape recorders, phono-players, etc., measured under weighted conditions in accordance with JIS C-5551 and DIN 45507 (same standards).

b. UNWTD (Unweighted): For measurement of the overall flutter content with use of the FITER RANGE switch, 19, and FILTER FREQUENCY dial, 20.

16 INDICATION switch: For flutter measurement readings -

a. PEAK (at in): Indication of the peak value (DIN and IEC).

b. RMS (at out): Indication of the effective value (JIS).

17 FLUTTER % switch: For setting the measuring ranges of the FLUTTER meter, 18.

18 FLUTTER meter: With two scales, 0-3 and 0-10, used in flutter measurements.

19 FILTER RANGE switch: Used in setting the range of the cutoff frequency of the lowpass filter at 0.1 times the input frequency.

20 FILTER FREQUENCY dial: For fine adjustment of the cutoff frequency of the lowpass filter.

21 POWER switch: For turning on the AC power for operation.

2.2 Rear Panel Items. Fig. 2-2 (Page -8-B-)

22 F-V connector: For the DC voltage output converted from the input signal frequency; output impedance is approximately 10kΩ, unbalanced.

23 DRIFT connector: For the drift component output; voltage is ±1V ±20% at full scale at all ranges; output impedance, 10kΩ ±20%.

24 TO SCOPE connector: For waveform observation or analysis of the flutter content; 3Vrms ±20% at full scale at all ranges; output impedance, 10kΩ ±20%, unbalanced.

25 TO RECORDER (Flutter component output): DC voltage proportional to the reading of the FLUTTER % meter, 18, is available at the connector recording; output is approximately 0.3V at the full scale meter reading; output impedance, 10kΩ ±20% at floating condition.

26 EXTernal FILTER terminals: INPUT for the filter input (approx. 100kΩ) and OUTPUT for the filter output (approx. 600Ω). Note: Both input and output connections are not balanced.

27 REFERENCE FREQUENCY switch: For selecting the reference frequency for the internal counter circuit -

50Hz or 60Hz for the local AC line frequency.

CRYSTAL (INTERNAL) for the internal 600kHz standard.

28 SINGLE PULSE ONLY switch: To be set at ON when the transducer generates only one pulse per revolution during the RPM measurement.

In this case, the MODE switch, 3, is set at FREQ. & REVO. ONLY for direct readout of the RPM.

29 VOLTAGE SELECTOR plug-in switch: For setting the AC input voltage condition. The arrow on the plug points in the direction of the voltage to be used, refer to the printed table above.

30 FUSEholder: For the AC line fuse.

31 AC INPUT cord.

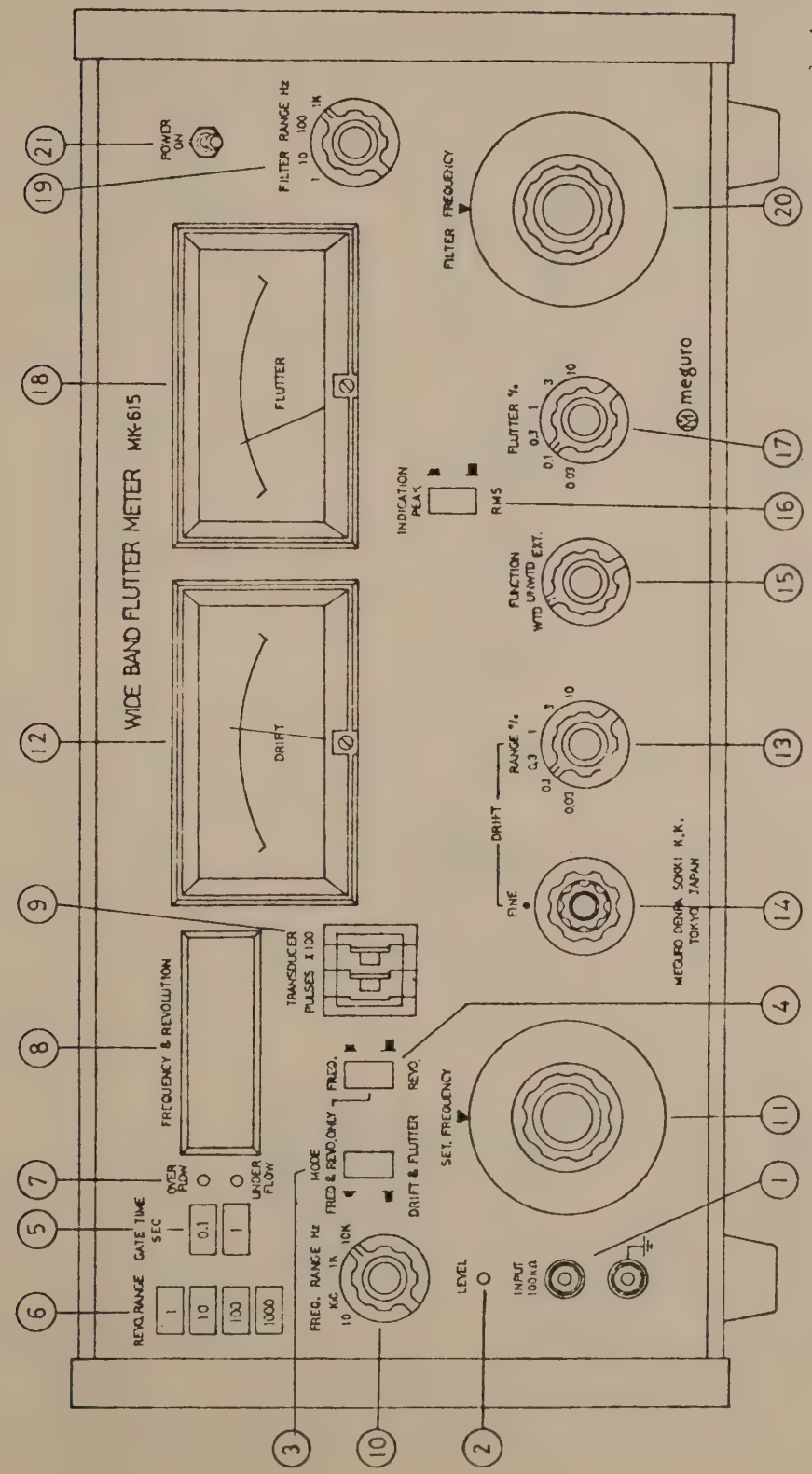


Fig. 2-1 Front panel controls.

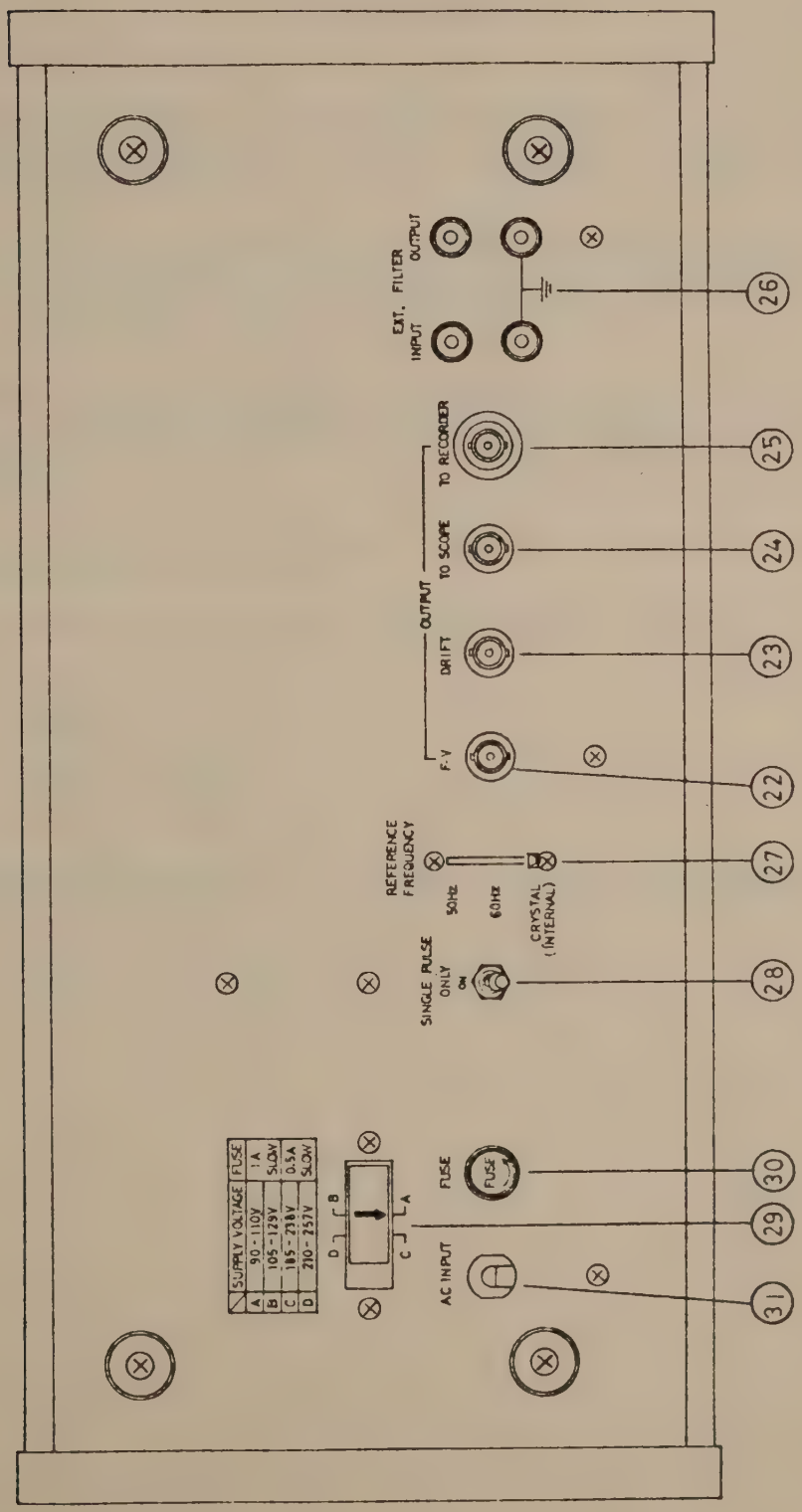


Fig. 2-2 Rear panel items.

SECTION 3

OPERATION

3.1 Precautions in Use

1. Make certain that the VOLTAGE SELECTOR plug, on rear panel is in the proper position to meet with the local AC line input voltage.

2. The AC line voltage should be within the range indicated in the printed table. This is to preserve the conditions for stability and accuracy, and also to prolong the life of the internal circuit components.

3. Before the POWER switch is turned on, check the mechanical "0" setting on the DRIFT % and FLUTTER meters. If off, adjust the center zero adjuster screw; use a small screw driver.

4. DC voltage, if present, across the INPUT 100kΩ terminals must not be over 100V.

5. The following output connections on the rear panel -

   F-V

   DRIFT

   TO RECORDER

   EXT. FILTER

   should not be connected to devices which have superposed DC in circuit.

6. The operating temperature range is 0 to 40°C.

3.2 Frequency Measurement

1. Set the POWER switch at off (down).

2. Check the VOLTAGE SELECTOR plug setting (on rear panel). It should be set at the local AC line voltage position.

3. Switch settings:

MODE	FREQ. & REVO. ONLY.
FREQ. - REVO.	FREQ.
GATE TIME	1 SEC.
REFERENCE FREQUENCY (on rear panel)	CRYSTAL.

4. Connect the AC cord plug to the AC line outlet.

   Set the POWER switch at ON. Allow about ten minutes for warm-up.

   The frequency unit will be displayed in the counter window.

5. Connect the input cord, MC-2204, between the INPUT 100kΩ terminals and the signal source.

   The LEVEL indicator will light when the proper input voltage is applied, i.e. in the 30mV-30Vrms range.

6. The OVERFLOW lamp will blink when the input frequency is higher than 9,999Hz. In this event, set the GATE TIME switch at 0.1 SEC; it will be possible to measure frequencies up to 99.99kHz.

   NOTE: When it is desired to synchronize the gate time with the local AC line frequency, set the REFERENCE FREQUENCY switch (on rear panel) at 50Hz or 60Hz as required.

3.3 RPM Measurement

1. Switch settings:

MODE	FREQ. & REVO. ONLY.
FREQ - REVO.	REVO.
REVO. RANGE	1...1000, as required.
SINGLE PULSE ONLY (on rear panel)	Off (down).
TRANSDUCER PULSES X100	At the divisor figure of the rotary encoder, i.e., at a multiple of 100 in the 100 to 9900 range.

2. Connect the input cord, MC-2204, between the INPUT 100kΩ terminals and the signal source.

   The LEVEL lamp will light when the input signal is in the 30mV-30Vrms range.

3. When the input signal frequency is within the range of the REVO.RANGE setting, the OVERFLOW and UNDERFLOW lamps should not be on. If either lamp is on, change the REVO.RANGE switch setting as required.

4. Use of the SINGLE PULSE ONLY function:

   When it is desired to measure the RPM using only one pulse generated with the rotary encoder or other rotary transducer, set the SINGLE PULSE ONLY switch (on rear panel) at ON.

   The RPM will then be directly indicated; the measuring range is 70 - 9,999RPM.

   NOTES: A. Under this condition, the REVO. RANGE switch setting and the UNDERFLOW lamp indication can be disregarded.

   B. When the OVERFLOW lamp blinks, it is an indication that the measuring range has been exceeded.

5. Use of Non-Multiple Divisor Figures

   When the divisor figure of the rotary encoder or other rotary transducer is not at a multiple fo "100:, the following conversion must be applied -

$$\frac{B}{A} \times C$$

where A = TRANSDUCER PULSES X 100 switch setting.

B = Divisor figure of the transducer.

C = Indicated value in RPM in the counter display.

The TRANSDUCER PULSESX100 switch should be set at the nearest figure corresponding to the divisor figure of the transducer.

For example, if the divisor is "360", set the switch at "03" or "04".

6. Use of the Divisor in the 1 - 60 Range

For transducer divisor figures at multiples of "1" up to 60, set the SINGLE PULSE ONLY switch (on rear panel) at ON.

The RPM reading as displayed is then divided by the divisor figure for the actual RPM.

15

3.4 Drift and Flutter Measurements

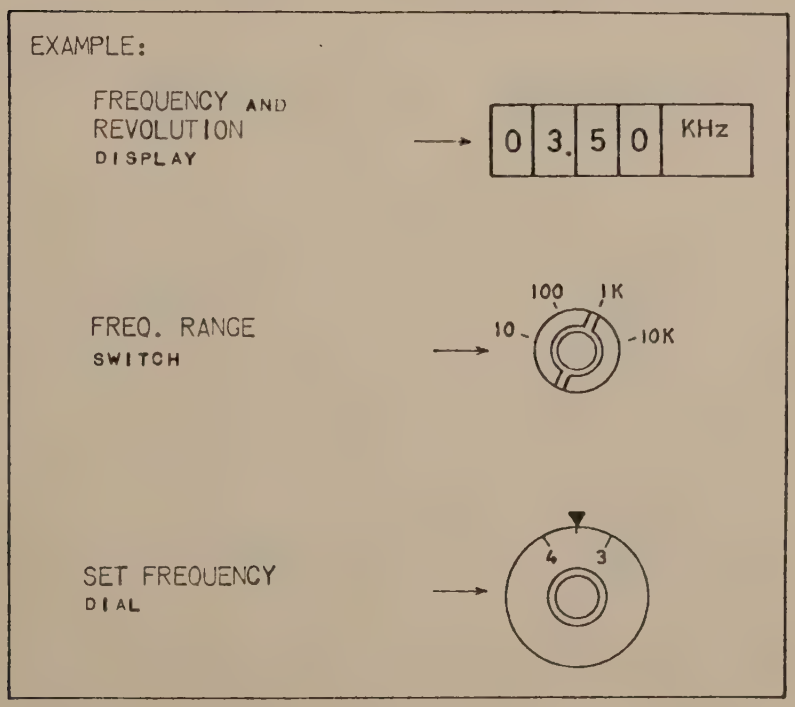
PRECAUTION -

1. When the input signal frequency is to be changed during drift and flutter measurements, always set the MODE switch at FREQ. & REVO. ONLY before the change is made.

2. To prevent possible damage to the DRIFT % and FLUTTER meters, do not change the input signal frequency with the MODE switch set at DRIFT & FLUTTER.

1. Initially, the procedures described in Sect. 3.2 on frequency measurements are followed for the input frequency display, namely - with the FREQ. RANGE switch at the range in use and with the SET FREQUENCY dial.

Settings for an example at 3.50kHz are shown in the figures below.



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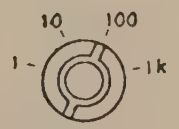
Other settings:

DRIFT RANGE %	10%.
DRIFT FINE dial	0.
FUNCTION switch	UNWTD.
INDICATION switch	PEAK or RMS, depending on the required indication.
FLUTTER % switch	10%.
FILTER RANGE switch and FILTER FREQUENCY dial	To set the lowpass filter cutoff at 1/10 of the input frequency. (At 350Hz in this example - see figures below.)

EXAMPLE:

FREQUENCY AND REVOLUTION DISPLAY

FILTER RANGE SWITCH



FILTER FREQUENCY DIAL

2. Set the MODE switch at DRIFT & FLUTTER.

3. Adjust the DRIFT FINE dial so that the DRIFT meter reads "0".

   Use the large knob for the 10%, 3%, and 1% ranges, and the small nob for other ranges.

   NOTES: 1. If drift is present in the input signal, set the DRIFT FINE dial so that the average meter reading is "0".

   2. If it is not possible to set the reading at "0", then slightly readjust the SET FREQUENCY dial and reset the DRIFT FINE dial.

4. Set the DRIFT RANGE switch at the required range.

   Adjust the DRIFT FINE dial so that the DRIFT meter reads "0".
   This point is the reference to be used in determining the frequency shift which is indicated in % on the DRIFT meter.

5. Next, set the FLUTTER % switch from 10% down until a reading is obtained reasonably high on the meter scale.

6. When measuring the flutter in tape recorders, phono-players, etc., set the FUNCTION switch at WTD.

   NOTE: The FUNCTION switch is provided for use of an external filter to be connected at the EXT. FILTER terminals (on rear panel). The filter input and output impedances respectively are 100kΩ and 600Ω.

7. The INDICATION switch is used for readings on the FLUTTER meter in terms of the PEAK or RMS (effective) value. It is important that this is designated on the result of measurements. Note that the "±" sign is used for the peak value.

8. The RPM can be measured at the same time with the drift and flutter by setting the FREQ. - REVO. switch at REVO.

9. Output connectors are provided (on rear panel) for use in recording and/or waveform observation.

CONNECTOR	OUTPUT DATA
DRIFT	±1V ±20% at open circuit, at full scale on all ranges; output impedance, approx. 10kΩ, unbalanced.
TO SCOPE	For flutter waveform observation on a scope; approx. 3Vrms, at open circuit, at full scale on all ranges; output impedance, approx. 10kΩ, unbalanced.
TO RECORDER	For flutter measurements; approx. 3V DC at full scale on all ranges; output impedance, approx. 10kΩ, floating condition.

10. The starting and stopping characteristics ("rise" and "fall" times) respectively of a motor, for example, can eb recorded with use of the F-V output (rear panel) connector.

In this case, set the MODE switch at FREQ. & REVO. ONLY and connect the F-V output to a recorder. The output voltage will depend on the setting of the FREQ. RANGE Hz switch and will be proportional to the frequency as shown in Fig. 3-1.

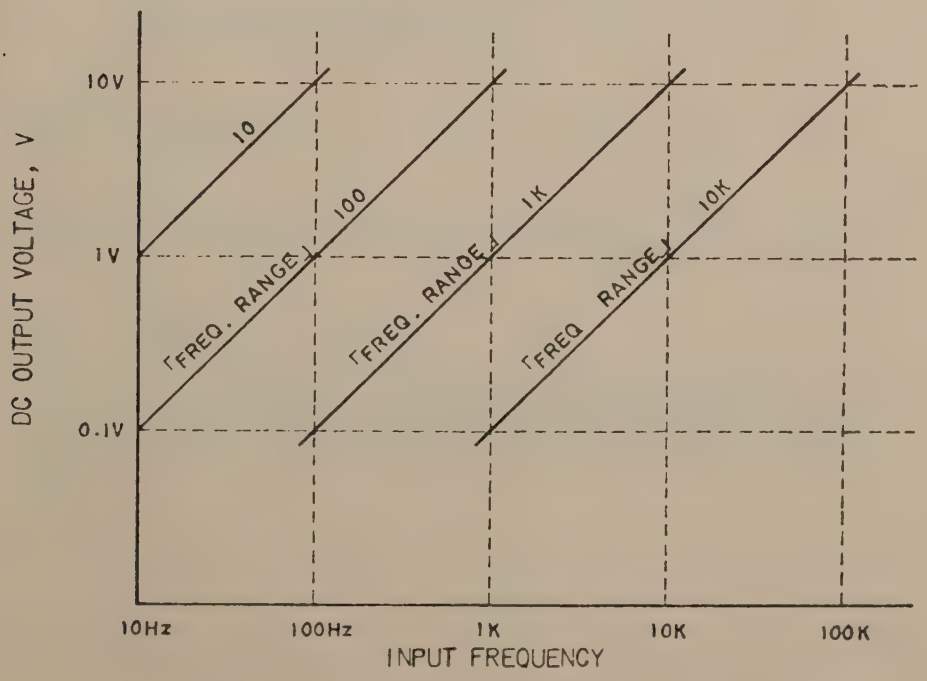


Fig. 3-1 Input frequency VS. output voltage.

3.5 Typical Applications

1. Use of a rotary encoder

Fig. 3-2 shows the equipment interconnections for measurement and recording of the flutter in a rotating device.

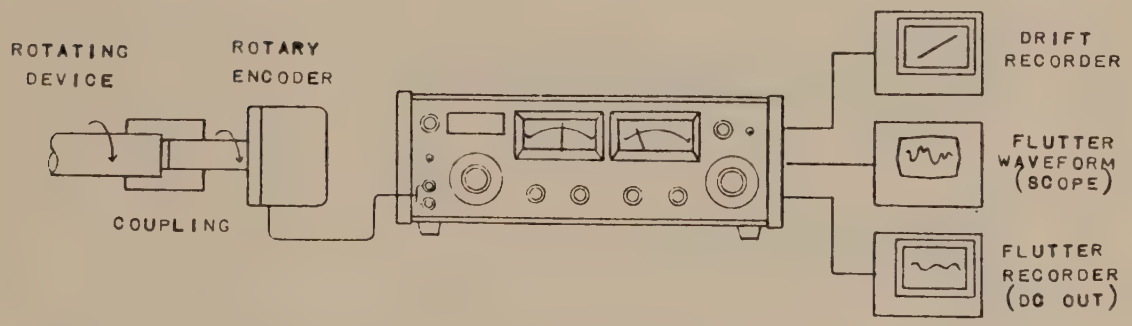


Fig. 3-2 Interconnections for flutter measurement.

The rotary encoder is connected to the INPUT 100kΩ terminals.

The RPM value is calculated from the following relation -

$$\frac{\text{COUNTER READING}}{\text{ENCODER DIVISOR FIGURE}} \times 60 = \text{RPM.}$$

The drift and flutter can be directly read out from the panel meters.

The recording and waveform observation (or analysis) are possible with suitable output connections as shown above.

2. Demodulation of FM signals

Due to the wideband characteristic, 20Hz-100kHz, of the instrument, it is possible to demodulate frequency modulated signals. The frequency modulation can be directly read out and the drift measured and recorded at the same time.

SECTION 4

CIRCUIT DESCRIPTION

4.1 General

The circuits used in the MK-615 for the measurements will be briefly described in this section.

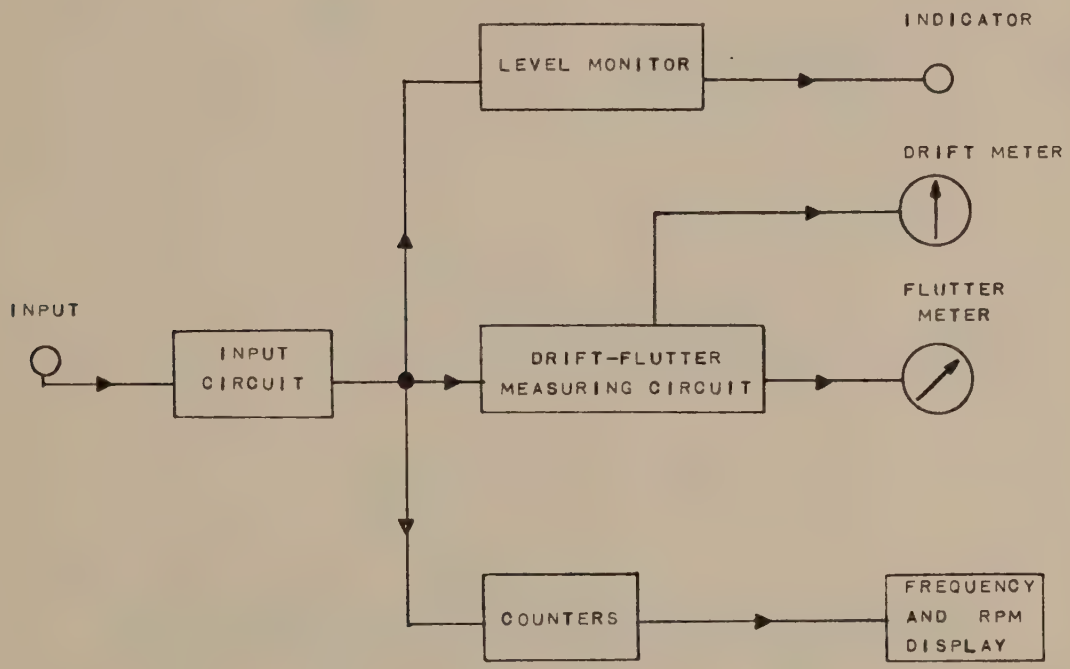


Fig. 4-1 Simplified block diagram: MK-615.

4.2 Input Signal Distribution

The signal under measurement is applied to an impedance converter, TR1.

At the output, the signal is distributed as shown in Fig. 4-2

NOTE: The figure in the box, ☐ , refers to the number of the schematic diagram.

1. Level Monitor Circuit [2]

This circuit is used to indicate that the proper input signal voltage required, 30mV - 30Vrms, for all measurements is being applied.

After amplification in IC1 and rectification, the LED driver is operated.

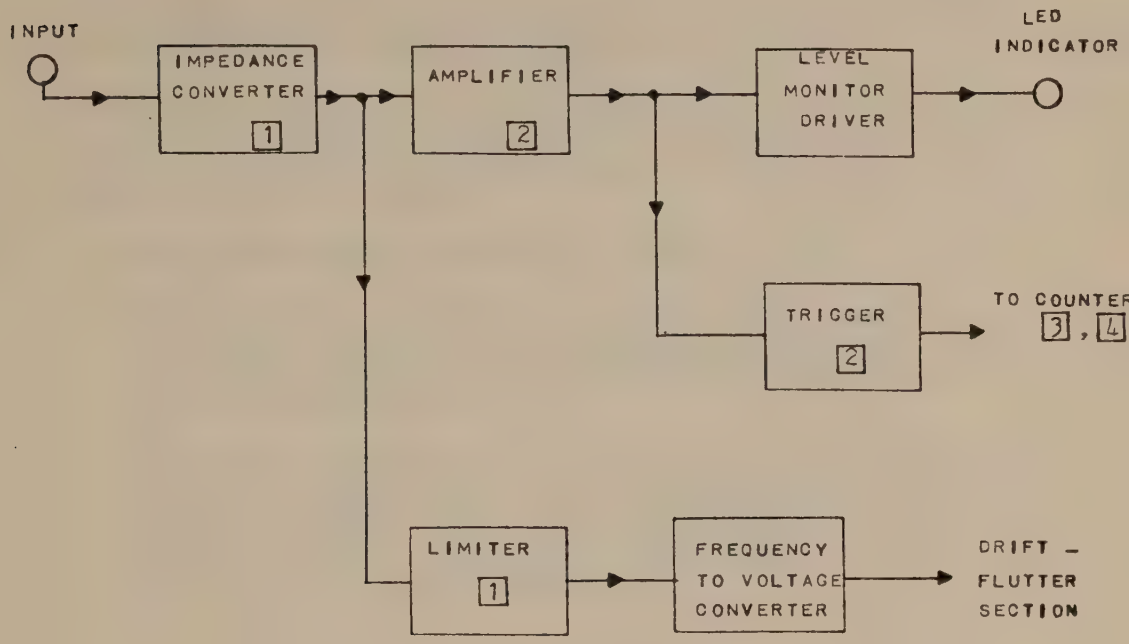


Fig. 4-2 Signal distribution.

2. Trigger Circuit [2]

The amplified signal is fed to the trigger, TR6-TR7, in order to generate the pulses used in the counters.

3. Limiter [1]

The input signal is applied to the limiter consisting of diodes, CD3-CD4, and IC1. The output is then fed to the frequency-to-voltage (F-V) converter where the signal is processed to be used in the drift-flutter measurements.

4. F-V, or Frequency-to-Voltage, Converter [1]

The F-V unit, IC2, is used to convert the input frequency up to 100kHz in four ranges. The output voltage is +10V, maximum, at each range. The output from the level monitor circuit is switched with the relay to the frequency ranging attenuators and the F-V output.

4.3 Drift and Flutter Circuits [1]

It will be noted that a relay, RLY1, is driven with the output signal from the level monitor. (This is when the input signal voltage is greater than 30mVrms.)

When the relay is at on, the F-V converter output is connected to the SET FREQUENCY attenuator, The other relay contact controls the MODE switching (on panel) for measuring the frequency and drift - flutter.

1. SET FREQUENCY and DRIFT FINE Adjusters

   R101 and R102 respectively, at the F-V converter output, are used to adjust the F-V output in proportion to the voltage. This is for the purpose of indicating the drift and flutter in % (percent).

   For example, in drift-flutter measurements, the output voltage will be proportional to the input frequency as shown in Fig. 3-1. When the input is at 100kHz and varies 10% (±10kHz) or again, input at 10kHz varies 10% (±1kHz) there is a difference of 10 times, see TABLE 4-1.

TABLE 4-1

Input Variation	Output Variation
100kHz ±10kHz	10V ±1V
10kHz ± 1kHz	1V ±0.1V

Thus, compensation is applied with the adjusters, SET FREQUENCY dial at the counter reading and DRIFT FINE dial for the DRIFT FINE dial for the DRIFT % meter reading at "O".

2. Amplifier I

   The IC3 circuit is used for the processed F-V converter output for drift - flutter measurements.

3. Drift Circuit

   After ranging for the drift ranges, Amplifier I output is fed to a lowpass filter, R34-C9 (cutoff, 0.2Hz) to take out only the drift component. Then the signal is amplified with IC4 to drive the center-0 DRIFT meter.

4. Flutter Circuit

   The flutter signal from Amplifier I is passed through a high-pass filter, C5-R37 (cutoff, 0.2Hz) to the impedance converter (gain, X1) TR2-TR3, and on to the active lowpass filter.

The active lowpass filter consists of two stages of tuned circuits connected in cascade. The overall roll-off characteristic is 24dB/octave. Basically, the cutoff frequency is set at 0.1 times the input frequency with the FILTER RANGE switch and FILTER FREQUENCY dial. However, when a wider flutter frequency range is required, the cutoff frequency can be extended, depending on the flutter content, see TABLE 4-2.

TABLE 4-2

FLUTTER, %	FILTER FREQUENCY (at cutoff)
0.3	$< \frac{\text{Input Frequency}}{10}$
0.3 – 3	$< \frac{\text{Input Frequency}}{5}$
3 – 10	$< \frac{\text{Input Frequency}}{3}$

The signal after filtering is ranged with the FLUTTER RANGE switch and fed to Amplifier III, IC5, and on to the FUNCTION switch for selection of the weighted network, unweighted (internal lowpass filter circuit) or the external filter.

The flutter signal is then applied to the metering circuits consisting of Amplifier IV (with linearizing rectifiers, CD6-CD9) and meter rectifiers for the peak and effective value indications.

5. Block Diagram

The simplified block diagram of the drift – flutter measuring section is shown in Fig. 4-3.

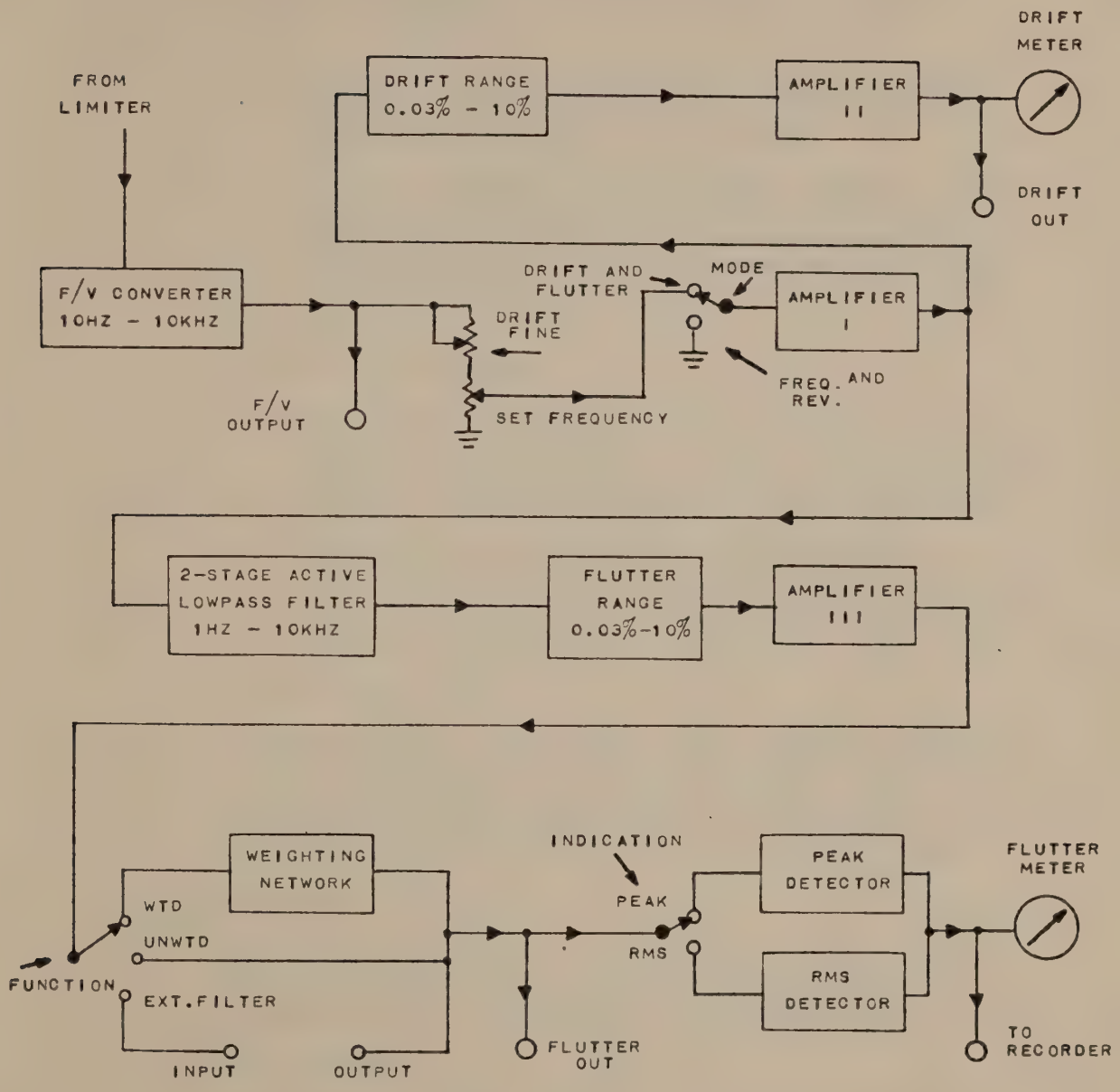


Fig. 4-3 Block diagram: Drift - Flutter measuring section

4.4 Frequency Counter [2]

1. The basic signal for the high performance in gating is generated as follows –

   a. Crystal oscillator: A part of the 600kHz oscillator output is stepped down by a factor of 60,000 with two stages of frequency divider circuits.

   b. AC line frequencies: The 50 or 60Hz frequency, repsctively, is fed to a trigger, TR8-TR9, to form pulses for feeding into the frequency dividers to produce 10Hz pulses. The 10Hz pulses thus formed are fed to the 1/10 frequency divider and the gate time changeover, and further to a divide-by-2 circuit.

2. Control Pulse Generator

   a. Memory Pulse Generation: This circuit is made up with a monostable multivibrator, IC12c, -d. When the gate is closed (end of counting), a pulse is generated which is fed to the memory to memorize the counted result.

   b. Reset Pulse Generation: Two stages of monostable multivibrators are used. From the time at which the memory signal has ended, the multivibrator, IC13a,-b, will operate and then multivibrator 14a,-b, will reset the counter.

3. Counter Memory Circuit

   The pulses from the gate circuit are counted and memorized in this circuit. Each of the ICs, IC5 and IC6, includescircuits for counting and memorizing the digits. Thus a 4-digit counter is formed with the two ICs. The results of counting and memorizing are fed into the respective BCD code.

4. Decoder [4]

   The decoder circuit is made up with IC1--IC4 in which the changeover is made with the BCD code signals from the counter-memory circuit to operate the 7-segment indicators.

5. Block Diagram

   The simplified block diagram of the frequency counter is shown in Fig. 4-4.

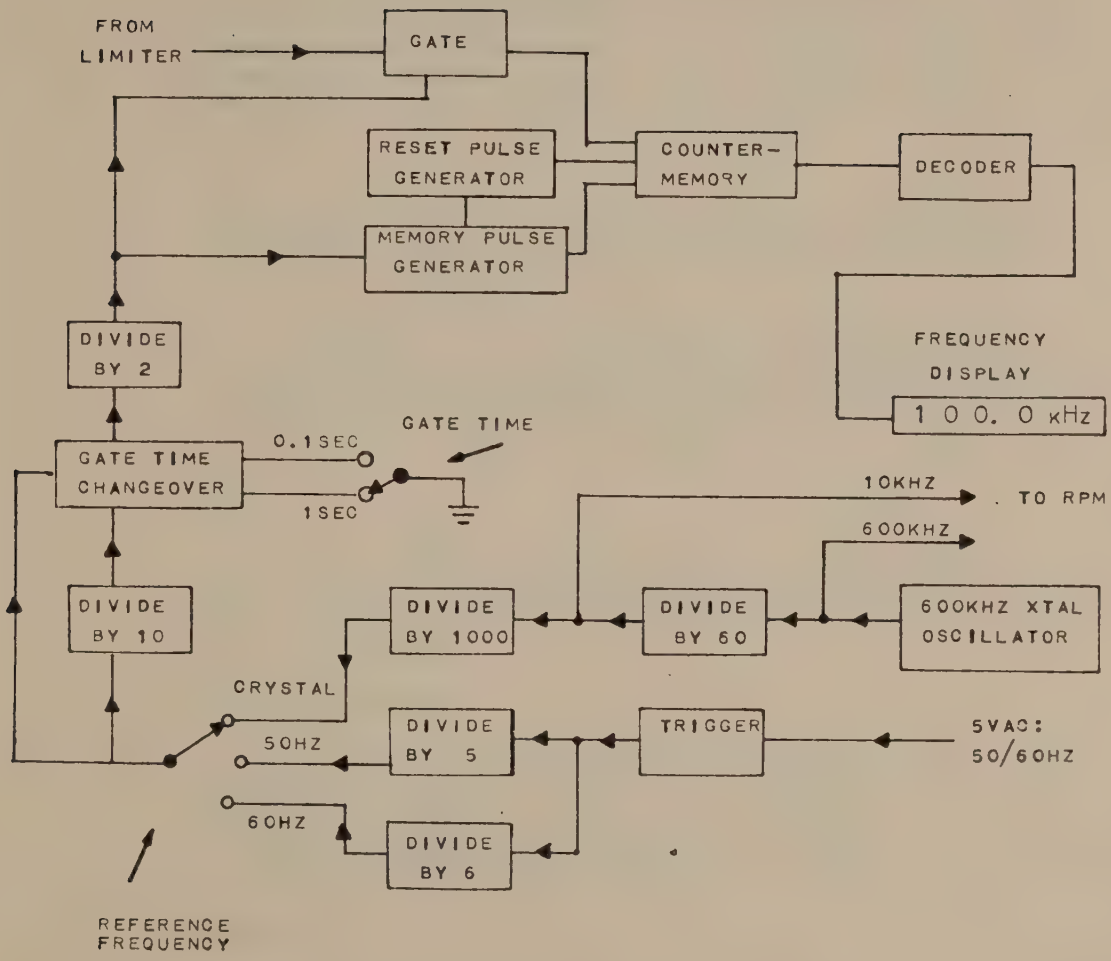


Fig. 4-4 Simplified block diagram: Frequency counter.

4.5 Revolutions (RPM) Counter [3]

This circuit utilizes the 1-second gate time.

In order to convert the frequency per second figure to RPM, it is required that a 60 times multiplication method is applied. The principle in the MK-615 is in use of a 10kHz figure as the reference signal for the period, T, of the input signal. Thus the counted result will be this reference signal divided by 600kHz.

1. Divider 1

   The input signal from the external rotary encoder or other transducer is fed to this circuit for the divisor figure in multiples of 100 up to 9900.

   IC4--IC5 are used to change the division ratio from the established external code as set the the TRANSDUCER PULSE X100 range switch (on panel). Thus at any division figure, one pulse per revolution divided by 100 will be generated.

2. Divider 2

   The 1/10, 1/100, and 1/1000 division is executed with IC1--IC3. This divider circuit is provided so that the range may be selected whereby the UNDERFLOW and OVERFLOW will not be indicated.

3. Counter Circuit

   This circuit is made up with IC8--IC9. The period of the revlution is taken as the gate time in order that the 10kHz reference signal will be counted in 4-digit form. Further, when the counter is "overloaded", counting is not possible and OVERFLOW will be indicated.

4. Memory Circuit

   IC13--IC16. The counted result is memorized herein and the output is used as the diviso to be applied to the divider system.

5. Divider System

   IC17--IC20. Operates as the count-down circuit. The 600kHz reference signal is divided by the code signal from the memory circuit. The result is applied to the frequency counter with a gate time of 1-second for indication in RPM.

6. Reset and Memory Pulse Generators

   For control of the counter and memory circuits. The necessary pulses are generated in monostable multivibrators, from IC10 for the memory and from IC11--IC12 for the counter.

7. The simplified block diagram of the RPM counter section is shown in Fig. 4-5.

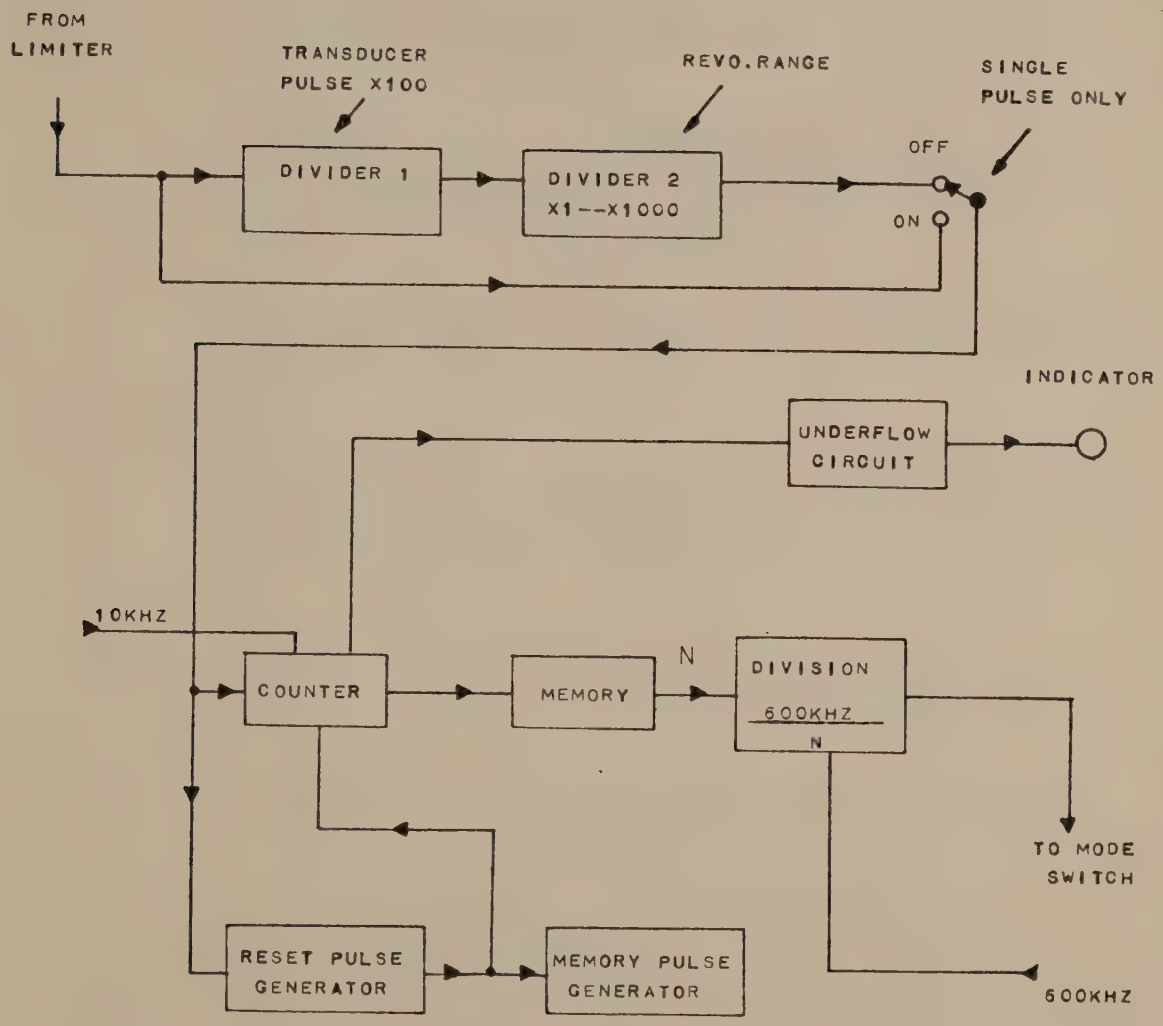


Fig. 4-5 Simplified block diagram: RPM counter section.

4.6 Power Supplies [5]

In the operation of the different circuits, three regulated DC power supplies, +15V, -15V, and +5V, are used.

1. +15V and -15V Supplies

   Both supplies are conventional and identical, and so the +15V section will be briefly described.

   The output from the full-wave rectifier, CD5, is used for both supplies. The "+" line output is controlled with the Darlington-connected Q101 and Q1 (in the control circuit). IC1 is differential amplifier which compares the +15V output with the voltage reference diode, CD2; further, the ripple content is reduced to less than 1mV.

   Diode, CD1, serves to maintain the DC voltage difference; Q2 is used as a current limiter to protect Q101 and Q1 against overloading.

2. +5V Supply

   An integrated unit, IC103m containing a rectifier and voltage regulating circuit, together with external filter capacitors, are used for this supply voltage.

3. AC Line Filter

   This filter is used to suppress unwanted pulse and other noise. It is effective in the 150kHz-15MHz range.

4. VOLTAGE SELECTOR

   Provided for four AC input ranges as shown in TABLE 4-3.

TABLE 4-3

AC LINE VOLTAGE	FUSE
A: 90-110V (100V±10%) B: 105-129V (117V±10%)	1A (slow)
C: 195-239V (217V±10%) D: 210-257V (234V±10%)	0.5A (slow)

LIST OF ELECTRICAL COMPONENTS

MK－615　　DRIFT & FLUTTER MEASURING CIRCUITS

PCB-1　　

Symbol	Description					Mfr. part No.	Note
C 1	C: fxd,	plastics,	0.47μF	±10%	100WV	CQ92MB2A474K	
C 2	C: "	Al elect,	10μF	±20%	25WV	25VBSN-10BP	
C 3	C: "	plastics,	0.1μF	±10%	100WV	CQ92MB2A104K	
C 3a	C: "	cer,	33pF	±5%	50WV	CC181CH330JY50	
C 4	C: "	"	0.047μF	+80%-20%	"	CK606YZB473ZZ50	
C 4a	C: "	dipped mica,	18pF	±10%	300WV	DM05YB180K3	
C 5	C: "	Al elect,	4.7μF	±20%	25WV	25VBSN-4R7BP	
C 6	C: "	dipped mica,	680pF	±10%	300WV	DM15YB681K3	
C 7	C: "	"	680pF	"	"	"	
C 8	C: "	plastics,	0.01μF	"	100WV	CQ92MB2A103K	
C 9	C: "	Al elect,	22μF	±20%	25WV	25VBSN-22BP	
C10	C: "	dipped mica,	100pF	±10%	300WV	DM05YB101K3	
C10a	C: "	cer,	8pF	±0.5pF	50WV	CC181CH080DY50	
C11	C: "	dipped mica,	100pF	±10%	300WV	DM05YB101K3	
C12	C: "	"	100pF	"	"	"	
C13	C: "	Al elect,	100μF	±20%	25WV	25VBSN-100BP	
C14	C: "	"	4.7μF	"	"	25VBSN-4R7BP	
C14a	C: "	dipped mica,	100pF	±10%	300WV	DM05YB101K3	
C15	C: "	plastics,	0.47μF	±2%	100WV	1MF0P47G	
C16	C: "	"	0.68μF	"	"	1MF0P68G	
C17	C: "	Al elect,	10μF	±20%	25WV	25VBSN-10BP	
C17a	C: "	cer,	33pF	±5%	50WV	CC181CH330JY50	
C18	C: "	Al elect,	100μF	±20%	25WV	25VBSN-100BP	
C19	C: "	"	47μF	"	"	25VBSN-47BP	
C20	C: "	Ta elect,	6.8μF	"	"	TFL25-6R8BP	
C21	C: "	"	6.8μF	"	"	"	
C22	C: "	"	6.8μF	"	"	"	
C23	C: "	"	6.8μF	"	"	"	
C24	C: "	Al elect,	47μF		"	25VBSN-47	
C25	C: "	"	47μF		"	"	
C26	C: "	"	470μF		"	25VBSN-470	
C27	C: "	"	470μF		"	"	

LIST OF ELECTRICAL COMPONENTS

MK – 6 1 5 DRIFT & FLUTTER MEASURING CIRCUITS

PCB–1

Symbol	Description				Mfr. part No.	Note
CD 1	Diode:	Si,	PIV 220V	100mA max	1S2462	
CD 2	Diode:	"	" 220V	"	"	
CD 3	Diode:	"	" 220V	"	"	
CD 4	Diode:	"	" 220V	"	"	
CD 5	Diode:	"	" 100V	1A max	F14A	
CD 6	Diode:	Ge,	" 20V	120mA max	1S73	
CD 7	Diode:	"	" 20V	"	"	
CD 8	Diode:	"	" 20V	"	"	
CD 9	Diode:	"	" 20V	"	"	
CD10	Diode:	"	" 20V	"	"	
CD11	Diode:	"	" 20V	"	"	
CD12	Diode:	"	" 20V	"	"	
CD13	Diode:	"	" 20V	"	"	
CD14	Diode:	"	" 20V	"	"	
CD15	Diode:	"	" 20V	"	"	
IC 1	Integrated Circuit:		OP AMP		CA3100T	
IC 2	Integrated Circuit:		F/V CONVERTER		MODEL-4704	
IC 3	Integrated Circuit:		OP AMP		TA7502BM	
IC 4	Integrated Circuit:		"		"	
IC 5	Integrated Circuit:		"		TA7506M	
IC 6	Integrated Circuit:		"		"	
L 1	Inductor:	fxd,	1μH	±5%	SP0410L-1R0K	
L 2	Inductor:	"	1μH	"	"	
L 3	Inductor:	"	1μH	"	"	
L 4	Inductor:	"	1μH	"	"	

LIST OF ELECTRICAL COMPONENTS

MK－615　　DRIFT & FLUTTER MEASURING CIRCUITS

PCB-1　　3/6

Symbol	Description					Mfr. part No.	Note
R 1	R: fxd,	metal film	300kΩ	±2%	1/4W	CRB1/4 300kΩGX	
R 2	R: "	"	1kΩ	"	"	" 1kΩGX	
R 3	R: "	"	1kΩ	"	"	" 1kΩGX	
R 4	R: "	"	13kΩ	"	"	" 13kΩGX	
R 5	R: "	"	10kΩ	"	"	" 10kΩGX	
R 6	R: "	"	100kΩ	"	"	" 100kΩGX	
R 7	R: "	"	10kΩ	"	"	" 10kΩGX	
R 8	R: "	"	330kΩ	"	"	" 330kΩGX	
R 9	R: "	"	1MΩ	±5%	1/2W	ML1/2 1MΩJ	
R10	R: var,	cermet	50kΩ	Lin	"	TM10K(PH)B50kΩ	
R11	R: "	"	5kΩ	"	"	" B5kΩ	
R12	R: fxd,	metal film	20kΩ	±2%	1/4W	CRB1/4 20kΩGX	
R13	R: var,	cermet	50kΩ	Lin	1/2W	TM10K(PH)B50kΩ	
R14	R: fxd,	metal film	200kΩ	±2%	1/4W	CRB1/4 200kΩGX	
R15	R: var,	cermet	500kΩ	Lin	1/2W	TM10K(PH)B500kΩ	
R16	R: fxd,	metal film	2MΩ	±5%	"	HRN1/2 2MΩJ	
R17	R: var,	cermet	1MΩ	Lin	"	TM10K(PH)B1MΩ	
R18	R: fxd,	metal film	22MΩ	±5%	"	ML1/2 22MΩJ	
R19	R: "	"	110Ω	±2%	1/4W	CRB1/4 110ΩGX	
R20	R: var,	cermet	20kΩ	Lin	3/4W	GFP122B20kΩ	
R20a	R: fxd,	carbon film	62kΩ	±5%	1/4W	R1/4 62kΩJ	
R20b	R: "	metal film	82kΩ	±2%	"	CRB1/4 82kΩGX	
R21	R: "	"	10kΩ	"	"	" 10kΩGX	
R22	R: "	"	390kΩ	"	"	" 390kΩGX	
R23	R: "	"	1.5kΩ	"	"	" 1.5kΩGX	
R24	R: "	"	510kΩ	"	"	" 510kΩGX	
R25	R: var,	cermet	1kΩ	Lin	3/4W	GFP10B1kΩ	
R25a	R: fxd,	metal film	1.3kΩ	±2%	1/4W	CRB1/4 1.3kΩGX	
R25b	R: "	"	8.2kΩ	"	"	" 8.2kΩGX	
R26	R: "	"	2kΩ	"	"	" 2kΩGX	
R27	R: "	"	1MΩ	±5%	1/2W	ML1/2 1MΩJ	
R28	R: "	"	100Ω	±2%	1/4W	CRB1/4 100ΩGX	
R29	R: "	"	1MΩ	±5%	1/2W	ML1/2 1MΩJ	
R30	R: "	"	56Ω	±2%	1/4W	CRB1/4 56ΩGX	
R31	R: "	"	820Ω	"	"	" 820ΩGX	

LIST OF ELECTRICAL COMPONENTS

MK－615　　DRIFT & FLUTTER MEASURING CIRCUITS

PCB－1　　4/6

Symbol	Description					Mfr. part No.		Note
R32	R: fxd,	metal film	510Ω	±2%	1W	CRB 1	510ΩGX	
R33	R: "	"	100Ω	"	1/4W	CRB1/4	100ΩGX	
R34	R: "	"	100kΩ	"	"	"	100kΩGX	
R35	R: "	"	1MΩ	±5%	1/2W	ML1/2	1MΩJ	
R36	R: "	"	5.6kΩ	±2%	1/4W	CRB1/4	5.6kΩGX	
R37	R: "	"	1MΩ	±5%	1/2W	ML1/2	1MΩJ	
R38	R: "	"	1.5kΩ	±2%	1/4W	CRB1/4	1.5kΩGX	
R39	R: "	"	510kΩ	"	"	"	510kΩGX	
R40	R: var,	cermet	10kΩ	Lin	3/4W	GFP122B10kΩ		
R41	R: "	"	50kΩ	"	1/2W	TM10K(PH)B50kΩ		
R42	R: fxd,	metal film	10kΩ	±2%	1/4W	CRB1/4	10kΩGX	
R43	R: "	"	62kΩ	"	"	"	62kΩGX	
R44	R: "	"	2.4kΩ	"	"	"	2.4kΩGX	
R45	R: "	"	6.2kΩ	"	"	"	6.2kΩGX	
R46	R: "	"	820Ω	"	"	"	820ΩGX	
R47	R: "	"	130kΩ	"	"	"	130kΩGX	
R48	R: "	"	16kΩ	"	"	"	16kΩGX	
R49	R: "	"	6.2kΩ	"	"	"	6.2kΩGX	
R50	R: "	"	110kΩ	"	"	"	110kΩGX	
R50a	R: "	"	330kΩ	"	1/2W	CRB1/2	330kΩGX	*a
R50b	R: "	"	330kΩ	"	"	"	330kΩGX	*a
R51	R: "	"	470Ω	"	1/4W	CRB1/4	470ΩGX	
R52	R: "	"	47kΩ	"	"	"	47kΩGX	
R53	R: "	"	1.2kΩ	"	"	"	1.2kΩGX	
R54	R: "	"	470Ω	"	"	"	470ΩGX	
R55	R: "	"	100Ω	"	"	"	100ΩGX	
R56	R: "	"	2.7kΩ	"	"	"	2.7kΩGX	
R57	R: "	"	470Ω	"	"	"	470ΩGX	
R58	R: "	"	910Ω	"	"	"	910ΩGX	
R59	R: "	"	100Ω	"	"	"	100ΩGX	
R60	R: "	"	1.5kΩ	"	"	"	1.5kΩGX	
R61	R: "	"	39kΩ	"	"	"	39kΩGX	
R62	R: "	"	4.7kΩ	"	"	"	4.7kΩGX	
R63	R: "	"	18kΩ	"	"	"	18kΩGX	
R64	R: "	"	2kΩ	"	"	"	2kΩGX	

LIST OF ELECTRICAL COMPONENTS

MK－615　　DRIFT & FLUTTER MEASURING CIRCUITS

PCB-1　　5/6

Symbol	Description					Mfr. part No.		Note
R65	R: fxd,	metal film	62kΩ	±2%	1/4W	CRB1/4	62kΩGX	
R66	R: "	"	8.2kΩ	"	"	"	8.2kΩGX	
R67	R: "	"	2.4kΩ	"	"	"	2.4kΩGX	
R68	R: "	"	82kΩ	"	"	"	82kΩGX	
R68a	R: "	"	330kΩ	"	1/2W	CRB1/2	330kΩGX	*a
R69	R: "	"	470Ω	"	1/4W	CRB1/4	470ΩGX	
R70	R: "	"	100kΩ	"	"	"	100kΩGX	
R71	R: "	"	470Ω	"	"	"	470ΩGX	
R72	R: "	"	1.5kΩ	"	"	"	1.5kΩGX	
R73	R: "	"	100Ω	"	"	"	100ΩGX	
R74	R: "	"	3.9kΩ	"	"	"	3.9kΩGX	
R75	R: "	"	3.9kΩ	"	"	"	3.9kΩGX	
R76	R: "	"	470Ω	"	"	"	470ΩGX	
R77	R: "	"	68kΩ	"	"	"	68kΩGX	
R78	R: "	"	3.3kΩ	"	"	"	3.3kΩGX	
R79	R: "	"	10kΩ	"	"	"	10kΩGX	
R80	R: "	"	100kΩ	"	"	"	100kΩGX	
R81	R: "	"	1.3MΩ	±5%	"	ML1/4	1.3MΩJ	
R81a	R: var,	cermet	500kΩ	Lin	1/2W	TM10K(PH)B500kΩ		
R82	R: fxd,	metal film	10MΩ	±5%	"	ML1/2	10MΩJ	
R83	R: "	"	1.2MΩ	"	1/4W	ML1/4	1.2MΩJ	
R84	R: var,	cermet	20kΩ	Lin	1/2W	TH10K(PH)B20kΩ		
R85	R: fxd,	metal film	68kΩ	±2%	1/4W	CRB1/4	68kΩGX	
R86	R: "	"	1kΩ	"	"	"	1kΩGX	
R87	R: "	"	100kΩ	"	"	"	100kΩGX	
R88	R: var,	cermet	10kΩ	Lin	1/2W	TH10K(PH)B10kΩ		
R89	R: fxd,	metal film	820Ω	±2%	1/4W	CRB1/4	820ΩGX	
R90	R: "	"	1.6kΩ	"	"	"	1.6kΩGX	
R91	R: "	"	1kΩ	"	"	"	1kΩGX	
R92	R: "	"	100kΩ	"	"	"	100kΩGX	
R93	R: "	"	47kΩ	"	"	"	47kΩGX	
R94	R: "	"	10MΩ	±5%	1/2W	ML1/2	10MΩJ	
R95	R: "	"	1.2MΩ	"	1/4W	ML1/4	1.2MΩJ	
R96	R: var,	cermet	20kΩ	Lin	1/2W	TH10K(PH)B20kΩ		
R97	R: fxd,	metal film	22kΩ	±2%	1/4W	CRB1/4	22kΩGX	

LIST OF ELECTRICAL COMPONENTS

MK－615　　DRIFT & FLUTTER MEASURING CIRCUITS

PCB－1　　6/6

Symbol	Description					Mfr. part No.	Note
R98	R: fxd,	metal film	11kΩ	±2%	1/4W	CRB1/4 11kΩGX	
R99	R: var,	cermet	10kΩ	Lin	1/2W	TH10K(PH)B10kΩ	
R99a	R: fxd,	metal film	30kΩ	±2%	1/4W	CRB1/4 30kΩGX	
R100	R: var,	cermet	100kΩ	Lin	1/2W	TH10K(PH)B100kΩ	
R101	R: fxd,	metal film	6.2kΩ	±2%	1/4W	CRB1/4 6.2kΩGX	
R101a	R: "	"	6.2kΩ	"	"	" 6.2kΩGX	
R102	R: "	"	10kΩ	"	"	" 10kΩGX	
R102a	R: "	"	10kΩ	"	"	" 10kΩGX	
R103	R: "	"	10kΩ	"	"	" 10kΩGX	
RLY 1	Relay:	DPST	12V	30mA		EMG-202	
TR 1	FET:	Si,	JUNCTION TYPE			2SK30A-Y	
TR 2	FET:	"	"			"	
TR 3	Transistor:	"				2SA495 Ⓖ-Y	
TR 4	Transistor:	"				2SC372 Ⓖ-Y	
TR 5	Transistor:	"				2SA495 Ⓖ-Y	
TR 6	Transistor:	"				2SC372 Ⓖ-Y	
TR 7	Transistor:	"				"	
TR 8	Transistor:	"				2SA495 Ⓖ-Y	
TR 9	Transistor:	"				2SC372 Ⓖ-Y	

*a　Factory selected, average value shown.

LIST OF ELECTRICAL COMPONENTS

M-K – 6 1 5 INPUT LEVEL MONITOR TIME BASE GENERATOR

PCB–2

Symbol	Description					Mfr. part No.	Note
C 1	C: fxd,	Al elect,	10μF	±20%	25WV	25VBSN–10BP	
C 1a	C: "	cer,	3pF	±0.25pF	50WV	CC181CJ030CY50	
C 2	C: "	Al elect,	100μF	±20%	25WV	25VBSN–100BP	
C 3	C: "	"	100μF	"	"	"	
C 4	C: "	"	10μF		"	25VBSN–10	
C 5	C: "	"	10μF	±20%	"	25VBSN–10BP	
C 6	C: "	"	10μF	"	"	"	
C 7	C: "	dipped mica,	150pF	±10%	300WV	DM10YB151K3	
C 8	C: "	plastics,	0.047μF	"	100WV	CQ92MB2A473K	
C 9	C: "	"	0.047μF	"	"	"	
C10	C: "	Al elect,	470μF		25WV	25VBSN–470	
C11	C: "	"	470μF		"	"	
C12	C: "	plastics,	4700pF	±10%	100WV	CQ92MB2A472K	
C13	C: "	"	0.047μF	"	"	" 473K	
C14	C: "	"	0.047μF	"	"	" 473K	
C15	C: "	"	0.047μF	"	"	" 473K	
CD 1	Diode:	Si, PIV	35V	120mA max		1S1588	
CD 2	Diode:	" "	35V	"		"	
IC 1	Integrated Circuit:		OP AMP			MLM301AG	
IC 2	Integrated Circuit:		DECADE COUNTER			SN7490AN	
IC 3	Integrated Circuit:		TWELVE COUNTER			SN7492AN	
IC 4	Integrated Circuit:		QUAD 2 NAND			SN7400N	
IC 5	Integrated Circuit:		TWELVE COUNTER			SN7492AN	
IC 6	Integrated Circuit:		DECADE COUNTER			SN7490AN	
IC 7	Integrated Circuit:		"			"	
IC 8	Integrated Circuit:		"			"	
IC 9	Integrated Circuit:		"			"	
IC10	Integrated Circuit:		"			"	
IC11	Integrated Circuit:		QUAD 2 NAND			SN7400N	
IC12	Integrated Circuit:		"			"	
IC13	Integrated Circuit:		"			"	

LIST OF ELECTRICAL COMPONENTS

MK – 615 INPUT LEVEL MONITOR TIME BASE GENERATOR

PCB-2

Symbol	Description	Mfr. part No.	Note
IC14	Integrated Circuit: QUAD 2 NAND	SN7400N	
IC15	Integrated Circuit: TWELVE COUNTER	SN7492AN	
R 1	R: fxd, metal film 10kΩ ±2% 1/2W	CRB1/2 10kΩGX	
R 2	R: " " 10kΩ " "	" 10kΩGX	
R 3	R: " " 330kΩ " "	" 330kΩGX	
R 4	R: var, cermet 100kΩ Lin "	TH10K(PH)B100kΩ	
R 5	R: fxd, metal film 1kΩ ±2% "	CRB1/2 1kΩGX	
R 6	R: " " 2.2kΩ " "	" 2.2kΩGX	
R 7	R: " " 100kΩ " "	" 100kΩGX	
R 8	R: " " 1kΩ " "	" 1kΩGX	
R 9	R: " " 1.2kΩ " "	" 1.2kΩGX	
R10	R: " " 2.2kΩ " "	" 2.2kΩGX	
R11	R: var, cermet 10kΩ Lin "	TH10K(PH)B10kΩ	
R12	R: fxd, metal film 47Ω ±2% "	CRB1/2 47ΩGX	
R13	R: " " 1kΩ " "	" 1kΩGX	
R14	R: " " 10kΩ " "	" 10kΩGX	
R15	R: " " 3.9kΩ " "	" 3.9kΩGX	
R16	R: " " 1kΩ " "	" 1kΩGX	
R17	R: " " 2.2kΩ " "	" 2.2kΩGX	
R18	R: " " 6.8kΩ " "	" 6.8kΩGX	
R19	R: " " 3.3kΩ " "	" 3.3kΩGX	
R20	R: " " 1kΩ " "	" 1kΩGX	
R21	R: " " 100Ω " "	" 100ΩGX	
R22	R: " " 10kΩ " "	" 10kΩGX	
R23	R: " " 3.9kΩ " "	" 3.9kΩGX	
R24	R: " " 1kΩ " "	" 1kΩGX	
R25	R: " " 1.2kΩ " "	" 1.2kΩGX	
R26	R: " " 1.2kΩ " "	" 1.2kΩGX	
R27	R: " " 2.2kΩ " "	" 2.2kΩGX	
R28	R: " " 470Ω " "	" 470ΩGX	
R29	R: " " 470Ω " "	" 470ΩGX	
R30	R: " " 2.2kΩ " "	" 2.2kΩGX	
R31	R: " " 470Ω " "	" 470ΩGX	

LIST OF ELECTRICAL COMPONENTS

MK－615　　INPUT LEVEL MONITOR TIME BASE GENERATOR

PCB-2　　

Symbol	Description	Mfr. part No.	Note
R32	R: fxd, metal film 2.2kΩ ±2% 1/2W	CRB1/2 2.2kΩGX	
TR 1	Transistor: Si,	2SC372 Ⓖ-Y	
TR 2	Transistor: "	"	
TR 3	Transistor: "	"	
TR 4	Transistor: "	"	
TR 5	Transistor: "	"	
TR 6	Transistor: "	"	
TR 7	Transistor: "	"	
TR 8	Transistor: "	"	
TR 9	Transistor: "	"	
XT 1	Crystal Unit: 600kHz HC33/U	XT-4675	

LIST OF ELECTRICAL COMPONENTS

MK-615 RPM COUNTER

PCB-3

Symbol	Description	Mfr. part No.	Note
C 1	C: fxd, plastics, 0.047μF ±10% 100WV	C092MB2A473K	
C 2	C: " " 0.047μF " "	" 473K	
C 3	C: " " 0.047μF " "	" 473K	
C 4	C: " " 0.047μF " "	" 473K	
C 5	C: " " 4700pF " "	" 472K	
IC 1	Integrated Circuit: DUAL J.K FLIP FLOPS	SN74107N	
IC 2	Integrated Circuit: DECADE COUNTER	SN7490AN	
IC 3	Integrated Circuit: DUAL DECADE COUNTER	MC14518BCP	
IC 4	Integrated Circuit: PROGRAMMABLE BCD COUNTER	MC14522BCP	
IC 5	Integrated Circuit: "	"	
IC 6	Integrated Circuit: HEX BUFFER	MC14050BCP	
IC 7	Integrated Circuit: QUAD 2 NAND	SN7400N	
IC 8	Integrated Circuit: DUAL DECADE COUNTER	MC14518BCP	
IC 9	Integrated Circuit: "	"	
IC10	Integrated Circuit: QUAD 2 NAND	SN7400N	
IC11	Integrated Circuit: "	"	
IC12	Integrated Circuit: "	"	
IC13	Integrated Circuit: QUAD LATCH	MC14042BCP	
IC14	Integrated Circuit: "	"	
IC15	Integrated Circuit: "	"	
IC16	Integrated Circuit: "	"	
IC17	Integrated Circuit: PROGRAMMABLE BCD COUNTER	MC14522BCP	
IC18	Integrated Circuit: "	"	
IC19	Integrated Circuit: "	"	
IC20	Integrated Circuit: "	"	
IC21	Integrated Circuit: QUAD 2 NAND	SN7400N	
IC22	Integrated Circuit: "	"	
IC23	Integrated Circuit: "	"	
IC24	Not assigned		
IC25	Integrated Circuit: DUAL D FLIP FLOPS	SN7474N	
IC26	Integrated Circuit: QUAD 2 NAND	SN7400N	
IC27	Integrated Circuit: DUAL D FLIP FLOPS	SN7474N	

LIST OF ELECTRICAL COMPONENTS

MK－615　　RPM COUNTER

PCB-3　　2/2

Symbol	Description	Mfr. part No.	Note
R 1	R: fxd, metal film 2kΩ ±2% 1/2W	CRB1/2 2kΩGX	
R 2	R: " " 2kΩ " "	" 2kΩGX	
R 3	R: " " 2kΩ " "	" 2kΩGX	
R 4	R: " " 2kΩ " "	" 2kΩGX	
R 5	R: " " 2kΩ " "	" 2kΩGX	
R 6	R: " " 2kΩ " "	" 2kΩGX	
R 7	R: " " 2kΩ " "	" 2kΩGX	
R 8	R: " " 2kΩ " "	" 2kΩGX	
R 9	R: " " 2kΩ " "	" 2kΩGX	
R10	R: " " 2kΩ " "	" 2kΩGX	
R11	R: " " 2kΩ " "	" 2kΩGX	
R12	R: " " 470Ω " "	" 470ΩGX	
R13	R: " " 470Ω " "	" 470ΩGX	
R14	R: " " 470Ω " "	" 470ΩGX	
R15	R: " " 2kΩ " "	" 2kΩGX	
R16	R: " " 2kΩ " "	" 2kΩGX	
R17	R: " " 2kΩ " "	" 2kΩGX	
R18	R: " " 330Ω " "	" 330ΩGX	
R19	R: " " 2kΩ " "	" 2kΩGX	
R20	R: " " 2kΩ " "	" 2kΩGX	
R21	R: " " 2kΩ " "	" 2kΩGX	
R22	R: " " 240Ω " "	" 240ΩGX	
R23	R: " " 240Ω " "	" 240ΩGX	
R24	R: " " 240Ω " "	" 240ΩGX	
R25	R: " " 2kΩ " "	" 2kΩGX	
R26	R: " " 330Ω " "	" 330ΩGX	
R27	R: " " 470Ω " "	" 470ΩGX	
R28	R: " " 8.2kΩ " "	" 8.2kΩGX	
TR 1	Transistor: Si,	2SC372 Ⓖ -Y	
TR 2	Transistor: "	"	

LIST OF ELECTRICAL COMPONENTS

MK-615 COUNTER

PCB-4

Symbol	Description	Mfr. part No.	Note
C 1	C: fxd, plastics, 4700pF ±10% 100WV	CQ92MB2A472K	
IC 1	Integrated Circuit: BCD-TO-SEVEN SEGMENT	MC14543BCP	
IC 2	Integrated Circuit: "	"	
IC 3	Integrated Circuit: "	"	
IC 4	Integrated Circuit: "	"	
IC 5	Integrated Circuit: DUAL DECADE COUNTER	MC14518BCP	
IC 6	Integrated Circuit: "	"	
R 1	R: fxd, metal film 220Ωx7 ±5% 1/8W	DIL-7C-220RJ	
R 2	R: " " 220Ωx7 " "	"	
R 3	R: " " 220Ωx7 " "	"	
R 4	R: " " 220Ωx7 " "	"	

LIST OF ELECTRICAL COMPONENTS

MK-615 LED DISPLAY

PCB-5

Symbol	Description	Mfr. part No.	Not
ND 1	LED: 7 segment LED Display	TLR313	
ND 2	LED: " "	"	
ND 3	LED: " "	"	
ND 4	LED: " "	"	
PL 1	Tangsten Lamp: 5V 60mA	No.31501 5V 60mA	
PL 2	Tangsten Lamp: 5V "	" "	

LIST OF ELECTRICAL COMPONENTS

MK－615　　DC POWER SUPPLIES

Symbol	Description	Mfr. part No.	Note
C 1	C: fxd, Al elect, 47μF, 25WV	25VBSN-47	
C 2	C: " " 47μF "	"	
C 3	C: " " 47μF "	"	
C 4	C: " " 470μF "	25VBSN-470	
C 5	C: " " 47μF "	25VBSN-47	
C 6	C: " " 47μF "	"	
C 7	C: " " 47μF "	"	
C 8	C: " " 470μF "	25VBSN-470	
CD 1	Diode: Break Down 6V 400mW	1N823A	
CD 2	Diode: " 6V "	"	
CD 3	Diode: " 6V "	"	
CD 4	Diode: " 6V "	"	
CD 5	Rectifier: Si, Bridged type	KBP-02	
IC 1	Integrated Circuit: OP AMP	LM741CH	
IC 2	Integrated Circuit: "	"	
R 1	R: fxd, ww 1Ω ±10% 2W	MS-2 1ΩK	
R 2	R: " metal film 15kΩ ±2% 1/2W	CRB1/2 15kΩGX	
R 3	R: " " 1.6kΩ " "	" 1.6kΩGX	
R 4	R: " " 910Ω " "	" 910ΩGX	
R 5	R: " " 6.8kΩ " "	" 6.8kΩGX	
R 6	R: var, cermet 5kΩ Lin 3/4W	GFP1641OSB5kΩ	
R 7	R: fxd, metal film 3.3kΩ ±2% 1/2W	CRB1/2 3.3kΩGX	
R 8	R: " ww 1Ω ±10% 2W	MS-2 1ΩK	
R 9	R: " " 1Ω " "	" 1ΩK	
R10	R: " metal film 15kΩ ±2% 1/2W	CRB1/2 15kΩGX	
R11	R: " " 1.6kΩ " "	" 1.6kΩGX	
R12	R: " " 910Ω " "	" 910ΩGX	
R13	R: " " 3.3kΩ " "	" 3.3kΩGX	
R14	R: var, cermet 5kΩ Lin 3/4W	GFP1641OSB5kΩ	
R15	R: fxd, metal film 6.8kΩ ±2% 1/2W	CRB1/2 6.8kΩGX	

LIST OF ELECTRICAL COMPONENTS

MK-615 DC POWER SUPPLIES

Symbol	Description	Mfr. part No.	Note
TR 1	Transistor: Si,	2SC1345 Ⓕ	
TR 2	Transistor: "	"	
TR 3	Transistor: "	2SA733	
TR 4	Transistor: "	"	

LIST OF ELECTRICAL COMPONENTS

Symbol	Description	Mfr. part No.	Note
C101	C: fxd, plastics, 10μF ±2% 100WV	1MFOP 1000G	
C102	C: " " 1μF " "	" 100G	
C103	C: " " 0.1μF " "	" 10G	
C104	C: " " 0.01μF " "	" 01G	
C105	C: " dipped mica, 820pF ±10% 300WV	DM15YB821K3	
C106	C: " plastics, 10μF ±2% 100WV	1MFOP 1000G	
C107	C: " " 1μF " "	" 100G	
C108	C: " " 0.1μF " "	" 10G	
C109	C: " " 0.01μF " "	" 01G	
C110	C: " dipped mica, 820pF ±10% 300WV	DM15YB821K3	
C111	C: " plastics, 0.1μF " 100WV	CQ92MB2A104K	
C112	C: " Al elect, 220μF 16WV	16VBSN-220	
C113	C: " " 2200μF "	16LASN-2200	
C114	C: " " 2200μF 50WV	50LASN-2200	
C115	C: " " 2200μF "	"	
CD101	LED: RED Diffused type	TLR104	
CD102	LED: "	"	
CD103	LED: "	"	
F101	Fuse: in glass tube 250V 1A	MF51NR250V1AAC01	
	Fuse Holder	FH-003	
FIL101	Noise Filter: 250V 3A AC max	ZGB2203-02	
IC101	Integrated Circuit: Regulator 5V 1A	EHD-RD3053R	

LIST OF ELECTRICAL COMPONENTS

Symbol	Description	Mfr. part No.	Note
J101	Terminal: Binding post type	MS-4304	
J102	Terminal: "	"	
J103	Connector: BNC 50Ω	BNC-047	
J104	Terminal: Binding post type	MS-4304	
J105	Terminal: "	"	
J106	Terminal: "	"	
J107	Terminal: "	"	
J108	Connector: BNC 50Ω	BNC-047	
J109	Connector: " 50Ω	"	
J110	Connector: " 50Ω	"	
M101	Meter: 100μA	DU-10 ±50μA	
M102	Meter: 100μA	" 100μA	
R101	R: var, carbon film 5kΩ Lin 1/4W	RV24YN20SB5kΩ	
R102	R: " " 500Ω:50Ω " "	RV24YD35RB500Ω:B50Ω	
R103	Not assigned		
R104	R: fxd, metal film 1kΩ ±2% 1/2W	CRB1/2 1kΩGX	
R105	R: " " 4.7kΩ " "	" 4.7kΩGX	
R106	R: " " 8.2kΩ " "	" 8.2kΩGX	
R107	R: " " 9.1kΩ " "	" 9.1kΩGX	
R108	R: " " 9.1kΩ " "	" 9.1kΩGX	
R109	R: var, carbon film 20kΩ Non Lin 1/4W	RV24YN20SC20kΩ	
R110	R: " " 200kΩ " "	" B200kΩ	
R111	R: " " 60kΩ " "	" B60kΩ	
R112	R: " " 60kΩ " "	" B60kΩ	
R113	R: fxd, metal film 1kΩ ±2% 1/2W	CRB1/2 1kΩGX	
R113a	R: " " 10kΩ " "	" 10kΩGX	
R114	R: " " 4.7kΩ " "	" 4.7kΩGX	
R115	R: " " 8.2kΩ " "	" 8.2kΩGX	
R116	R: " " 9.1kΩ " "	" 9.1kΩGX	
R117	R: " " 9.1kΩ " "	" 9.1kΩGX	
R118	R: " " 2.4kΩ " "	" 2.4kΩGX	

LIST OF ELECTRICAL COMPONENTS

Symbol	Description	Mfr. part No.	Note
R119	R: fxd, ww 1Ω ±10% 2W	MS-2 1ΩK	
S101	Switch: push button, 1 button, 4 sections	KA014e-SR-CB-BB	
S102	Switch: rotary, 2 sections, 6 positions	B2111D	
S103	Switch: " 4 " 4 "	B4205D	
S104	Switch: " 2 " 6 "	B2111D	
S105	Switch: " 2 " 3 "	B1205D	
S106	Switch: push button, 1 button, 4 sections	KA014e-SR-CB-BB	
S107	Switch: toggle, DPDT	ST1206N	
S108	Switch: push button, 1 button, 6 sections	KA016e-SR-CB-BB	
S109	Switch: Lever, 2 sections, 3 positions	L-1022	
S110	Switch: push button, 4 buttons, 2 sections	KH042e-LR-CB-BB	
S111	Switch: " 2 " 2 "	KH022e-LR-CB-BB	
S112	Switch: toggle, DPDT	ST1206N	
S113	Switch: Thumbwheel switch, 2 stations	CTS-3200-2	
T101	Transformer: POWER SUPPLY 31.63VA	PT-2613A	
TR101	Transistor: Si,	2SC790Y	
TR102	Transistor: "	2SA490Y	
VS101	VOLTAGE SELECTOR	SC-335	
"	"	PC-235	

PCB-1
PCB-2
IMPEDANCE CONVERTER
LIMITER
OP-AMP
INPUT
J101
J102
TR1 2SK30A-Y
CI CA3100T
F/V CONVERTER
IC2 MODEL-4704
IN
SUM
SET. FREQ.
DRIFT
F/V OUTPUT J103
W&F
S101
F rpm
DRIFT →
S102
PCB-6
DRIFT RANGE
0.03 %
0.1 %
0.3 %
1 %
3 %
10 %
J109 DRIFT OUTPUT
M101 DRIFT
AMP. II TA7502BM
IC4
TP4
AMP I TA7502BM
IC3
TR2 2SK30A-Y
TR3 2SA495 G-Y
← FLUTTER
S107
FREQ. RANGE Hz
10K
1K
100
10
ACTIVE LOWPASS FILTER
TR4 2SC372 G-Y
TR5 2SA495 G-Y
TR6 2SC372 G-Y
TR7 2SC372 G-Y
TR8 2SA495 G-Y
TR9 2SC372 G-Y
LP FILT. I
LP FILT. II
AMP III IC5 TA7506
WTD NET WORK
IC6 TA7506
S104
S105
FUNCTION
WTD
UNWTD
EXT.
J104 EXT
J106 IN
J105
J107
EXT. FIL.
INDICATION
S106
PEAK
RMS
TRACKING
TO RECORDER OUTPUT
J110
M102
FLUTTER
J108 TO SCOPE (FLUTTER)
S103
SET FREQUENCY
FIL. RANGE
FLUTTER RANGE
0.03 %
0.1 %
0.3 %
1 %
3 %
10 %
+15V
-15V
GND

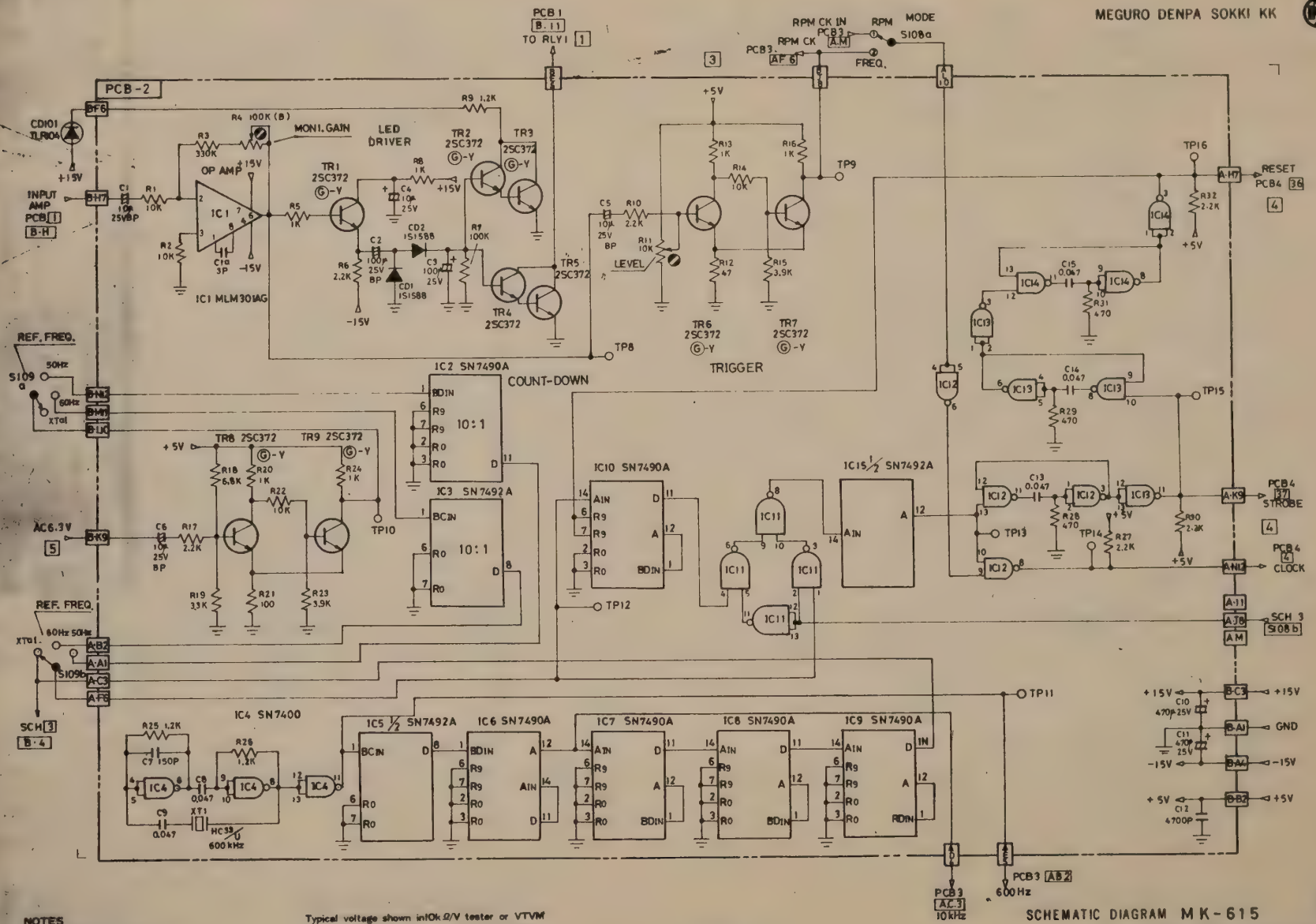
C101, C106	10μ
C102, C107	1μ
C103, C108	0.1μ
C104, C109	0.01μ
C105, C110	820P

Resistor 1/4W

CHANGES:
DRAWING: SH10NO
CHECK:
DATE: 1975:10

SCHEMATIC DIAGRAM: MK-615
PCB:1 DRIFT & FLUTTER MEASURING CIRCUITS

MEGURO DENPA SOKKI KK



SCHEMATIC DIAGRAM MK-615

2

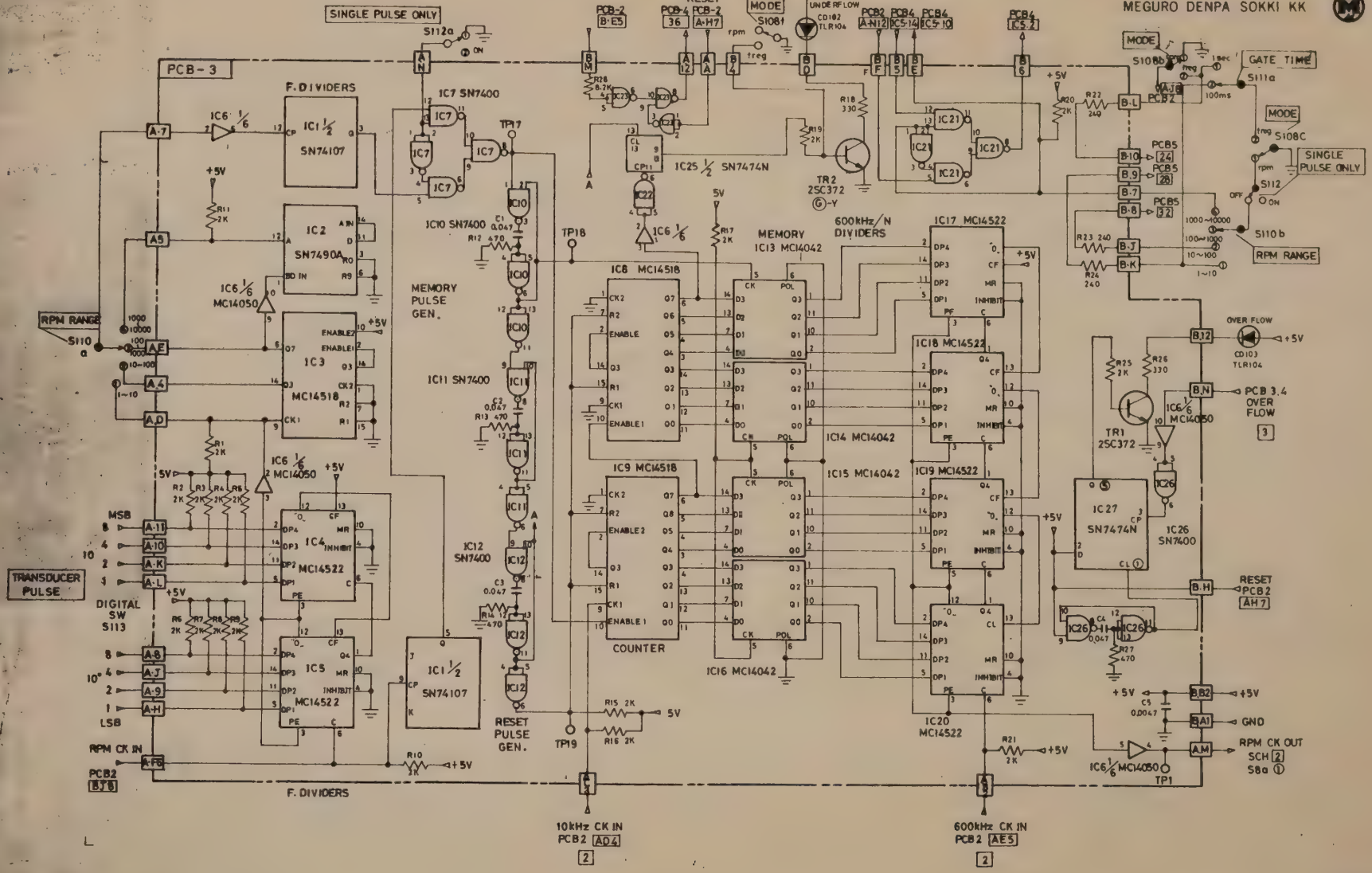
PCB-2 INPUT LEVEL MONITOR
TIME BASE GENERATOR

NOTES
Unless otherwise indicated:
Resistance in Ω, k=kΩ, M=MΩ
Resistors 1/2watt
Capacitance in pF μ=μF
NAME Screwdriver adjustment in case
[NAME] Screwdriver adjustment on panel

Typical voltage shown in10k Ω/V tester or VTVM
Rotary switch section shown in max CCW position
* Value selected at factory; Average value shown
PCB Printed Circuit Board
2) Connector or Terminal number

CHANGES:
DRAWING: SHIONO
CHECK:
DATE: 1975.10

MEGURO DENPA SOKKI KK



NOTES
Unless otherwise indicated:
Resistance in Ω, k=kΩ, M=MΩ
Resistors 1/2watt
Capacitance in pF μ=μF
NAME Screwdriver adjustment in case
NAME Screwdriver adjustment on panel
NAME Knob control and Panel markings

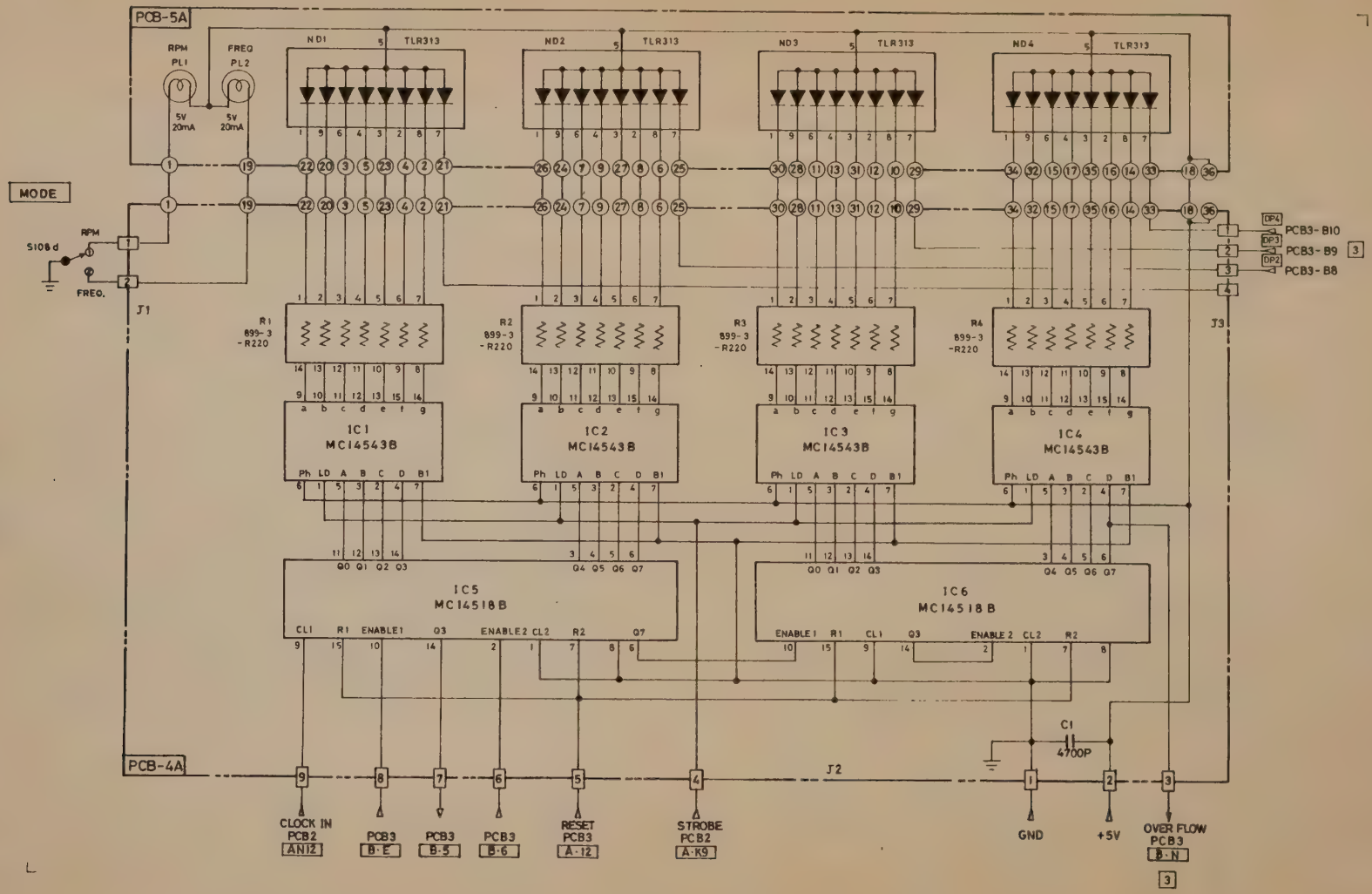
Typical voltage shown in10kΩ/V tester or VTVM
Rotary switch section shown in max CCW position
* Value selected at factory; Average value shown
PCB Printed Circuit Board
② Connector or Terminal number

CHANGES:
DRAWING: SHIONO
CHECK:
DATE: 1975.10

SCHEMATIC DIAGRAM MK-615

RPM COUNTER

3



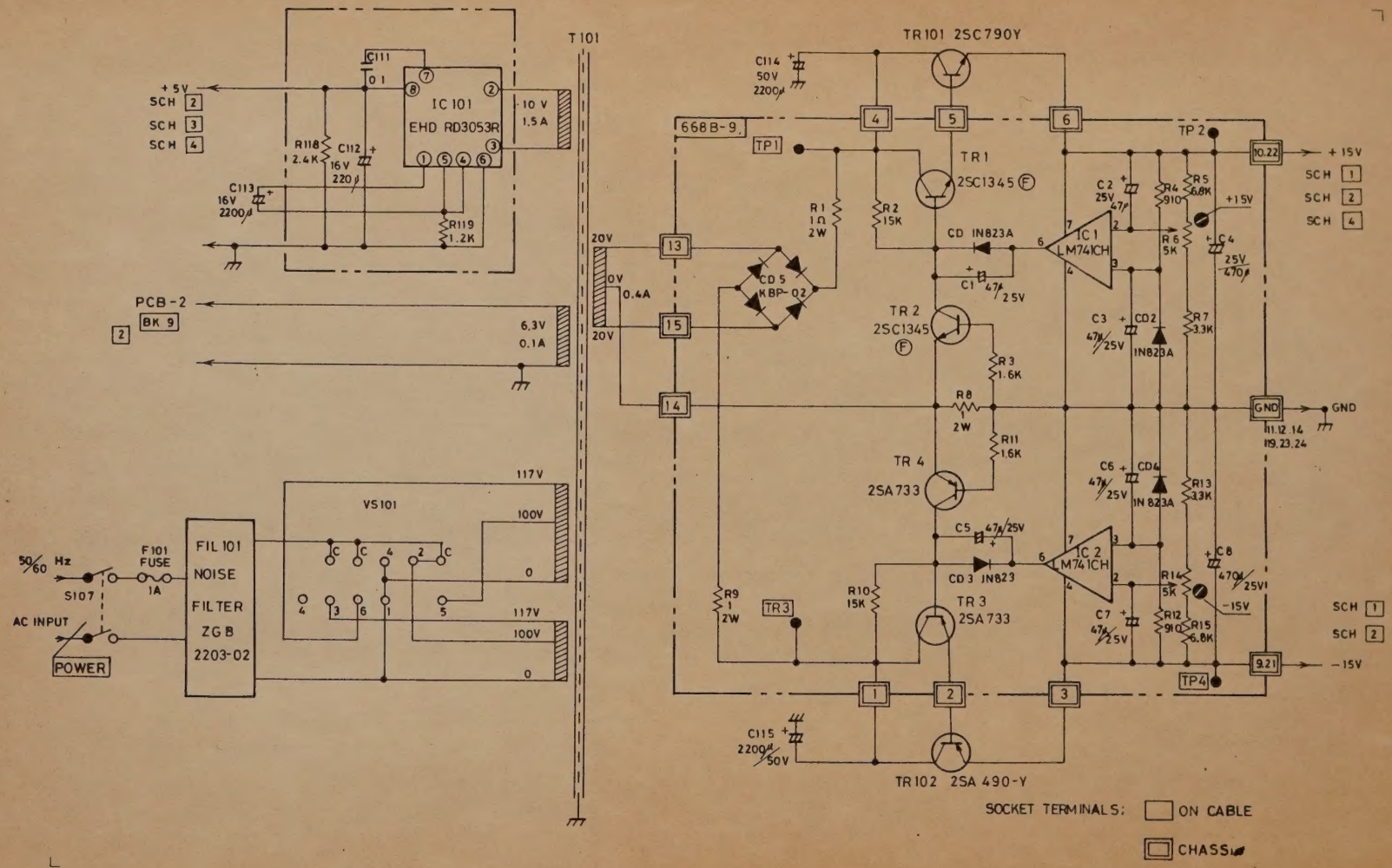
NOTES
Unless otherwise indicated:
Resistance in Ω, k=kΩ, M=MΩ
Resistors 1/2watt
Capacistance in pF μ=μF
NAME Screwdriver adjustment in case
NAME Screwdriver adjustment on panel
NAME Knob control and Panel markings

Typical voltage shown in10kΩ/V tester or VTVM
Rotary switch section shown in max CCW position
※ Value selected at factory; Average value shown
PCB Printed Circuit Board
Connector or Terminal number

CHANGES:
DRAWING: KAJIYAMA
CHECK:
DATE: 1981. 8

SCHEMATIC DIAGRAM MK-615
PCB4 : COUNTER
PCB5 : LED DISPLAY

4



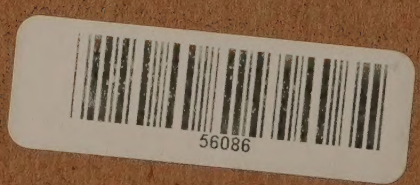
NOTES
Unless otherwise indicated:
Resistance in Ω, k=kΩ, M=MΩ
Resistors 1/2watt
Capacistance in pF μ=μF
NAME Screwdriver adjustment in case
NAME Screwdriver adjustment on panel

Typical voltage shown in10kΩ/V tester or VTVM
Rotary switch section shown in max CCW position
※ Value selected at factory; Average value shown
PCB Printed Circuit Board
② Connector or Terminal number

CHANGES: 1978.9
DRAWING: SHIONO
CHECK:
DATE: 1974.3

SCHEMATIC DIAGRAM MK-615
668B-9 DC POWER SUPPLIES

5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